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THE EFFECT OF ETHYL ALCOHOL ON THE ELECTROENCEPHALOGRAPHIC SLEEP STAGES OF MAN

Richard B. Yules

Thesis presented to the Faculty of Yale University School of Medicine in partial fulfillment of the requirements for the degree of Doctor of Medicine

Department of Psychiatry
School of Medicine
Yale University
1966

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TO MY PARENTS

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INTRODUCTION

The electroencephalogram (EEG) of a night's sleep can be divided into four stages: Stage I characterized by 7 - 13 waves/second of fast low voltage activity or the stage characterized by rapid eye movements (REMs), Stage II characterized by two or more K complexes and/or two spindles, Stage III characterized by three but fewer than ten delta waves (2-3/second slow high voltage waves) in each twenty second interval, and Stage IV characterized by a greater than ten delta waves in each twenty second interval (1, 2). This classification of the human sleep pattern provides the basis for much of the present research on sleep and the basis for the experiments reported herein.

In spite of much research, little is known about Stage II, III, and IV sleep. It is apparent, however, that the slowness of the EEG is also reflected in a decreased and steady heart rate (3), a decreased and steady respiratory pattern (4), and a decreased and constant blood pressure (5, 3), compared to Stage I sleep. But since a

subject is more easily wakened by a tone in Stage II - IV sleep than in Stage I sleep (1) and since muscle tone is increased (6), Stages II - IV should not be regarded as "deeper" sleep but rather as "slower". Because "deprivation" or interruptions in Stage IV sleep by waking have produced no compensatory increase in Stage IV time (7), there is no indication of a "need" for Stage IV sleep; but since no drugs have been found to alter Stage IV sleep time, there is inadequate evidence to determine any such "need". The slower stages of sleep -- Stages II - IV - exist and encompass 75% of a normal person's sleeping time (8), but as yet elude investigators as to their function and determining neural structures and/or humors.

The other of the four sleep stages, Stage I REM, has been more extensively and more successfully studied. The stage's characteristic rapid eye movements were first reported by a Yale philosophy professor, H. T. Ladd, in 1892 (9). In 1937 Loomis (10) related these sleeping eye movements to the fast low voltage cortical activity which he called Stage B. It was not until 1953 that Aserinsky

and Kleitman (11) investigated the relationship of REM periods to dreaming and used the Stage I designation now employed in classifying EEG sleep stages.

In the past seven years accumulated data indicates that Stage I REM is not peculiar to man, but is found in every mammal in which REMs are sought (12) including monkey (13), cat (14), sheep (15), rabbit (16), rat (17), mouse (18), dog (19), goat (20), chimpanzee (21), and opposum (22). Even the average length per REM period (5 - 10 minutes) and its percentage of total sleep time (20 - 30 %) is remarkably similar from animal to animal. It is the cat and man which have been used in most research.

The development of REM periods in the human is of theoretical significance in view of the evidence to be presented for a correlation between REMs and dreaming. The highest per-cent of sleep time in Stage REM is spent by premature infants (50 - 80 %) (23) and neonates (45 - 65 %) (24) in which over half of their sleep time

is spent in REM. Considering the large amount of time neonates spend in sleep (over 75% of their day) (12), their absolute REM time must be very high. The per-cent of time in REM drops in a two year old infant (25 - 40 %) (24), to a level of 20 - 25% in young adults (2) such as used in this study. REM per-cent continues to decrease after thirty years of age to a low value of 13 - 18% in 50 - 70 year olds (12). The high neonatal REM time of humans is also reported to occur in kittens (25). It may be that the REM state is most characteristic of undeveloped animals.

The physiological changes which occur during REM periods are essentially the contrapositive of those during Stages II - IV since autonomic function is heightened (26, 27) while vigilance and muscle tone are reduced. During REM sleep pulse rate and blood pressure are more labile - fluctuating more rapidly and maintaining higher levels (3). Respiration is also more irregular (4), brain temperature and blood flow go up (28, 29), and penile erections occur in 95% of REM periods but

never in non-REM periods or during Stage II - IV sleep (30). In spite of heightened autonomic activity, vigilance and muscle tone are decreased during REM periods. The early investigator, Loomis (10), found it more difficult to wake subjects with a tone during REM sleep. Over the past twenty years, several investigators have found subjects in REM periods less responsive to conditioned stimuli (26). Kleitman (8) reviews over sixty studies which indicate that subjects' responsiveness to faradic stimuli, bristle touch, pin prick, bells, buzzers, and bright light is decreased cyclically with the onset of REM periods.

First noted in cat cervical neck muscles (31, 32), muscle tone decrease is now accepted as synchronous with REM periods. The reduction in tone is present in muscles innervated by cranial nerves. The most reliable muscle in humans appears to be the submental complex where tone decrease was reported present in 76 out of 77 REM periods (6). Some laboratories use only muscle tone decrease as an index of REM time, allowing electronic computers to

automatically program with only this one variable (33). This author has succeeded in finding a single electrode which in cats can record both REMs and muscle tone; muscle tone decreased in 66 consecutive REM periods in all three implanted animals (34). It is possible that muscle tone will supplant REMs as a measure of the Stage I REM state.

The occurrence, development, and physiology of the REM stage has occupied much research time, but the psychic phenomena associated with REM periods has provoked the speculation. Since the REM state was first implicated as a dream state by waking subjects (11), many laboratories have taken up the task of determining when subjects dream by waking them either on the basis of EEG stages or randomly. A recent review by Hartman (12) presented data from 12 papers using 142 subjects who were awakened 2518 times. When awakened in the REM stage there was a dream report indicence of 74% compared to 18% when awakened in non-REM stages. Although the first REM period used to be thought of as a non-dream

period, recent evidence indicates it, too, is associated with dream recall (35). Because of the acceptance of the REM state as a time of dreaming and the feeling by some that REMs represent the observer looking during his dreams (36, 37, 38, 39, 40), investigators have attempted to manipulate the time a subject can spend in Stage I REM sleep.

Both waking procedures and drugs have been employed to alter REM time. Dement (7, 146) was the first to demonstrate the effect of interrupting REM periods - an effect which he called "dream deprivation". Using eight subjects, he interrupted their sleep from three to seven nights by waking them when the EEG record showed REMs; he reduced their REM time through waking by 80 - 90%. On the first recovery night REM time increased from control levels of 20% to 30% in seven of the eight subjects. Dement found that it took more wakenings (and the subjects were more difficult to wake) on successive REM deprivation nights. Similar wakenings during non-REM sleep produced no such increase; Dement interpreted

this data as evidence of a "need" for dreaming or REM. Recently Dement has reported dream depriving three subjects for 15 consecutive nights; the resulting rebound REM time on recovery nights reaches as high a level as 60% (41). Cats also show REM deprivation from waking as well as rebound phenomena (32). Other investigators' findings (42) support Dement's data and although some authors question the concept of dream deprivation (43), the rebound of Stage REM (regardless of its meaning) is accepted (44).

Total night REM time is now reported altered by two drugs: amphetamine and haptabarbitone. The amphetamine study (45) employed three subjects who slept in the laboratory for five consecutive nights. On the first three nights, two subjects were given 15 mg amphetamine and 100 mg phentobarbital; the third subject received this regimen for four nights. All three subjects showed a decrease in REM time from predetermined control levels of about 25% to 15% during the first drug night; although REM time approached

control levels on succeeding drug nights, it was not until the drug was stopped that REM time exceeded control levels (32% in the three drug night subjects, 50% in the four drug night subject). In addition to the change in per-cent for total night REM time, latency or time to the first REM period increased when subjects maintained a low REM time (the first drug night), but decreased during high REM time nights. Heptabarbitone (400 mg) has been shown in six patients to decrease REM time from a control value of 21% to 14% when administered on a single night; unfortunately no recovery nights were studied (46). Only the stimulant, amphetamine, has been studied for consecutive nights (three) and for recovery nights (two); neither amphetamine, barbiturates, nor alcohol have been studied in animals.

The effect of alcohol on the EEG of waking animal and man is well known. In both, alcohol from 50 mg% through higher levels produces a slowing of brain waves, an increase in amplitude, and an excess of delta waves (47, 48, 49, 50, 51, 52, 53, 54).

The effect of alcohol on sleeping animals has not been assessed. Only one study of its effect on sleeping man has been published (55). The REM time was decreased in four out of seven subjects during the first five hours of sleep after a 1 g EtOH / Kg body weight dose. However, its effect on the total night's REM, on any of the other EEG sleep stages, and on the rebound on recovery nights was not determined. No drugs have been found to increase REM time.

Data on the REM periods now provides for determining quantitatively the change induced in REM time by waking or drugs. The REM periods occur cyclically five or six times each night at regular intervals of 80 - 90 minutes, last an average of 15 minutes, and thereby account for 20 - 25% of sleep time in a 20 - 40 year old man (11, 36, 37, 38, 2, 44); the REM periods in cats cycle every 40 - 60 minutes, last an average of 10 minutes, and encompass from 20 - 40% of their total sleep time (32, 56, 12). Differences between values for REM periods in normals and chronic schizophrenics (57, 58, 59), acute schizophrenics (60),

and depressed patients (61, 46) have not been found. Although two reports in single individuals (62, 63) claim elevated REM times (29% and 50% respectively), longitudinal studies have failed to demonstrate consistent differences between the REM time of the mentally ill and the "normal" controls. Interesting as yet, unpublished datum(64) does suggest that alcoholics spend over 80% of their sleep in Stage I REM while in delirium tremens.

The mechanism by which changes in REM time are effected is being studied. Although data is not yet published as to whether changes in REM time are due to changes in the number of REM periods or the length of the periods, CNS structures affecting REM and its initiation have been described (65). Jouvet has provided most of the relevant neurophysiological data related to CNS control of REM states. Jouvet first found that decorticate animals as well as "cerveau isole" (middle mesencephalic transection) animals could still maintain REM stages; but transections at the lower border of the pons removed the animal's

ability to maintain a REM state (32). Between these latter two transections was found a central pontine nucleus (nucleus reticularis pontis caudalis) which if destroyed by electrocoagulation produced a cat which could maintain a waking and a non-REM sleeping state, but which could not maintain a REM state (66). He postulated that this nucleus was necessary to initiate if not sustain REM periods (67).

The effects of chronic brain stem lesions on cortical and muscular activity of the sleeping and waking cat have been studied by a Harvard medical student, J. Allan Hobson, working in Jouvet's laboratory (68). Using twelve cats Hobson concluded that the periodic muscular atonia of REM sleep was progressively inhibited as lesions were placed more caudally in the ponto-mesencephalic brain stem, and that the reticular formation was necessary and sufficient for this periodic atonia. These experiments provided the basis for Jouvet's localizing a new nucleus - the nucleus caeruleus - a nucleus which if electrocoagulated left an animal in a constant state of REM

until it died two to four weeks later (69). With this last finding still unpublished, one can conclude that the pontine-mesencephalic reticular formation contains centers necessary for initiating and inhibiting REM sleep (70, 71, 72).

The neurochemistry is less well understood than the neurophysiology of sleep. Significant findings from this fascinating field are as yet unpublished, but some data are available from several laboratories. Jouvet claims (69) that his newly discovered nucleus caeruleus is rich in noradrenaline and very vascular - suggesting an area responding to some hypothetical neuromodulator. Dement claims to have increased REM time in a normal cat by injecting cerebrospinal fluid from a REM deprived cat into the recipient cat's CNS ventricle (71) - further suggesting the presence of a neuromodulator.

No further evidence for a neuromodulator is available; however studies of CNS neurohumors have been initiated. Gross shifts in concentrations of acetylcholine (ACh) and serotonin in the brains of

sleeping and waking animals occur. Hartman reported (72) that REM time is increased in humans given reserpine (a drug which blocks the uptake of and depletes stores of serotonin). Jouvet (69) has found that REM deprived cats return to control levels of REM in one day after being given reserpine, a change taking ten days if reserpine is not administered; he has concluded that serotonin is responsible for "slow wave" sleep but does not act on REM sleep, a conclusion which is not inconsistent with Hartman's findings. Finally Freedman and Bowers (73) have demonstrated that REM deprived rats have low brain cortical ACh levels compared to non-REM deprived rats. These findings demonstrate shifts of biochemicals in the sleeping animal and inspire further research in the neurochemistry of sleep.

SUMMARY

Sleep is divided into four EEG stages. Stage II - IV represent a state of decreased autonomic activity, a state of relatively high vigilance, and a state of relatively high muscle tone; little is known of the function or neurophysiology of this slow wave sleep. Stage I sleep, on the other hand, represents a state with rapid eye movements, increased autonomic activity, decreased vigilance, and decreased muscle tone. REM Stage I or fast sleep is correlated with dreaming; attempts to lower REM time by waking and administering drugs have produced high REM times on recovery nights. The neurophysiology is partly worked out; its neurochemistry is being actively investigated.

This thesis presents studies of the effect of ethyl alcohol on a total night's sleep (an effect as yet unstudied) for five consecutive nights (a period of time for any drug administration as yet unreported) in order to evaluate changes taking place in the four EEG sleep stages over consecutive drug and recovery nights.

SUBJECTS

The subjects were three male graduate students of ages 21, 23, and 25. No subject had a history of mental or physical disease; and none were more than, but all were, social drinkers. Each subject was interviewed by Dr. Daniel X. Freedman, a psychiatrist, and judged mature enough to undertake the experiment.

Each subject signed a paper exempting Yale University from responsibility and was told before the experiment that he would receive $75.00 for fifteen consecutive nights of sleep in the hospital electroencephalography laboratory. Each was told that he would drink the ethyl alcohol equivalent of six shots of whiskey before retiring, but the subject was uncertain on what night or nights he would receive the alcohol. All subjects agreed not to drink for one week prior to and throughout the experiment and also not to sleep, outside of the experimental setting. Each slept his normal amount of sleep time, eight hours for subject 1, and seven hours for subjects 2 and 3.

MATERIALS AND METHODS

The subjects reported to the Grace New Haven Community Hospital EEG laboratory at 11:00 PM. During the next fourty-five minutes disc electrodes were applied as described below. At 11:15 the subjects started to drink 200 ml of fresh orange juice on control and post-alcohol nights and 1 g/Kg body weight of ethyl alcohol in orange juice (total volume of 200 ml) on experimental nights, completing their drinking by 11:45. In the next fifteen minutes they urinated and prepared for bed. In bed with the electrodes plugged into the connector box, a blood sample for blood alcohol level was drawn for determination by the hospital clinical laboratory. The subjects slept on a spring and mattress in an air-conditioned room. Lights were turned out at midnight and the subject slept his normal amount of sleep time, being awakened in the morning.

Before setting Grass silver coated disc electrodes in place, the subject's skin was washed with an ether-alcohol mixture to remove skin oil and dirt. Over Grass permanent EEG paste, electrodes were fastened to the skin of the face with Johnson and Johnson non-allergenic surgical tape and to the skin beneath the hair of the scalp with cotton and collodion. EEG tracings were taken as shown in Figure 2 from two monopolar conjugate eye leads, one frontal lead, one temporal lead, one parietal lead, and from a bipolar temporo-occipital lead. These correspond in the International 10/20 System to leads FpA, CA, PA, and TO.

Electrode leads were united to form one line which extended from the top of the subject's head to a connector box mounted on the wall adjacent to the headboard of the bed. From the connector box a shielded cable ran through the wall of the copper enclosed sleeping quarters to the selector panel of a Grass Model VII polygraph on which all EEG tracings were recorded.

The polygraph was calibrated so that 50 microvolts registered a 7 mm deflection and was operated at a speed of 20 seconds to one page of record with 60 cycle filters engaged throughout the experiment. The polygraph was tended by a technician at all times.

The EEG records were scored page by page for the entire night (1500 pages/night) according to the method of Dement (1) and Williams (2). For a page in a collection greater than three pages (60 seconds), the record was staged as follows:

AW --- fast activity of 8-12 cps with muscle artifact present in all leads,

I --- alpha activity without spindles or K complexes,

II --- 2 spindles, 2 K complexes, or one of each, with less than 3 delta waves,

III --- 3 or more but less than 1/2 of page of delta waves (1-3 cps high voltage waves),

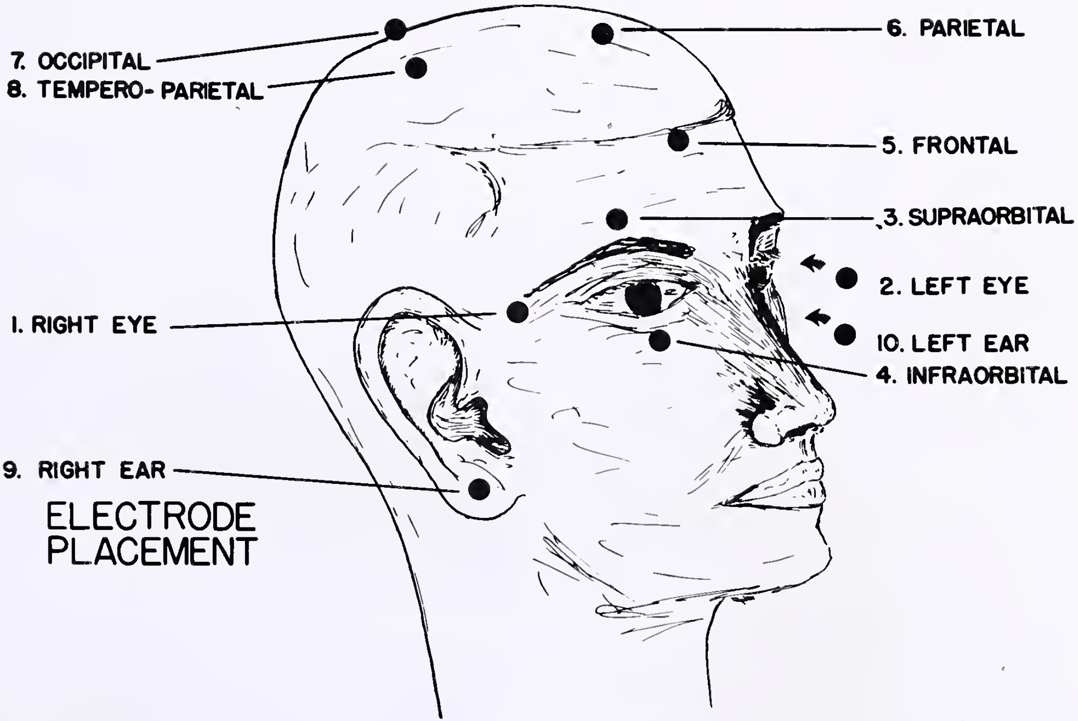
IV --- greater than 1/2 page of delta waves.

Stage AW, I, II, III and IV were scored separately. Since Stage I without REM is such a small portion of total Stage I (2), Stage I and REM Stage I were combined. A page was scored as a body movement if

greater than 1/2 page was filled with muscle artifact, and this was not part of an AWake period. The number of stage shifts as well as the latency period to the first REM period with REMS greater than 50 µv were also computed. Since the dose of alcohol was calculated to be metabolized to an insignificant blood level in one half of the night, all data was analyzed in terms of the total night, first half night, and second half night. The first two control nights were not scored and were run to allow the subject to acclimate to his new environment.

In order to make certain accumulated consecutive nights did not produce significant effects within themselves, the experiment was arranged so that in subjects 2 and 3, four control nights preceded five alcohol nights, and in subject 1, five alcohol nights were run first. Subject one's control level was determined several months before the start of the experiment.

Figure 1 shows the location of the electrodes on a model head. Photographs of electrodes on a subject are included in appendix figures 6 – 9.



ELECTRODE
PLACEMENT

STATISTICS

With the aid of Doctor Kenneth Chandler, a statistician in the Department of Psychology, control nights, alcohol nights, and post-alcohol recovery nights were compared using the Mann Whitney U test as described in Siegel (74). Modalities analyzed included Stage I REM time, AWake time, body movements, and the number of stage shifts.

RESULTS

The analysis of the data provided for a multitude of figures and variables. Rather than confront the reader with this mass of data, only results which are thought to be critical in the discussion will be presented here; all other results will be systematically presented in Appendix Part B.

The data are divided into total nights, first half nights, and second half nights for each of the three subjects; further analysis includes percent of time in each stage, number of stage shifts, pages of body movements (BM), and latency time to the first REM. A composite recording of Stage I for all subjects is included in Table 1; the means of all stages are plotted in Figure 2 which presents an overall picture of all stage shifts for the total night, for the first half of the night, and for the second half of the night.

The following applies to all of the subjects:

1. Stage I REM decreases the first alcohol night but on subsequent alcohol nights gradually increases and exceeds control levels; following withdrawal of the alcohol, the high Stage I REM stabilizes and gradually returns to control levels by the fourth recovery night. This shift in Stage I - the initial decrease on the first night and the increases on subsequent night - takes place both in the first half of the night and in the second half of the night. Stage I normally occupies the largest percentage of time of any stage during

the second half of the night and does so on alcohol nights.

2. Stage II varies inversely with Stage I, increasing proportionally to any Stage I decrease and decreasing proportionally to any Stage I increase.

3. Stage III and IV fluctuate about control levels. Stage IV normally occupies the largest percentage of time of the first half of the night, and does so on alcohol nights.

The sleep stage pattern of Subject 1 presented in Figures 3 and 4 is representative of all the subjects, and demonstrates the pattern of sleep stages on consecutive nights as outlined above.

4. The percent of time spent in Awake is not significantly greater on alcohol nights ($\underline{p} > 0.05$).

5. There is no statistically significant difference in body movements on alcohol nights compared with control nights ($\underline{p} > 0.05$).

6. The number of stage shifts for each subject remains approximately the same on all nights including alcohol nights. The length of each stage shift is proportional to the per-cent of time spent in that stage (Figure 2).

7. The latency to the first REM is the same on control and post-alcohol nights but varies unsystematically on alcohol nights. When latency is shorter the number of shifts until the first REM is less, and the number of shifts is greater when latency is longer. The latency values for each subject are presented in Table II.

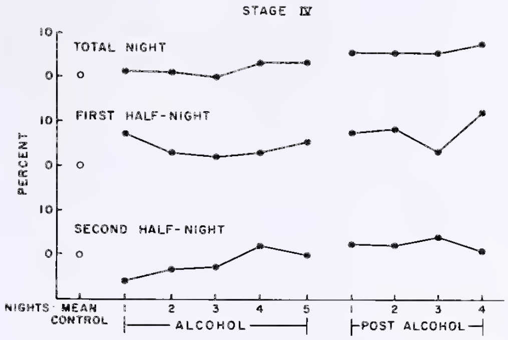
TABLE I

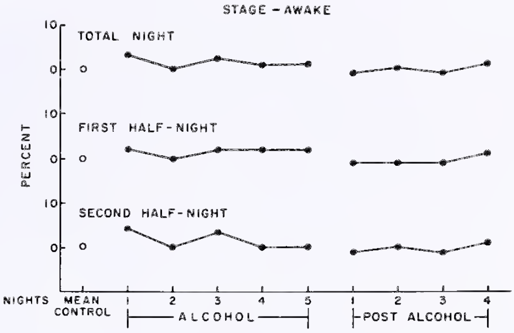
PERCENT OF TIME IN STAGE I (REM)

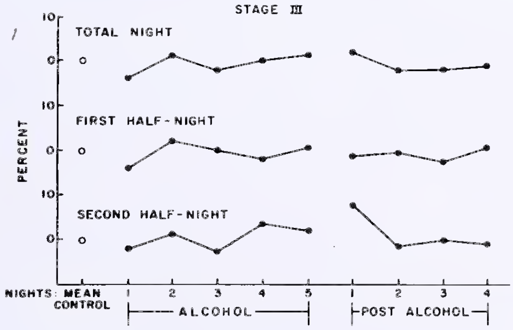
DIVISION OF NIGHT FOR ANALYSIS	NIGHTS		CONTROL	ALCOHOL					POST-ALCOHOL			
			MEAN*	1	2	3	4	5	1	2	3	4
TOTAL	Subject	1	24	19	23	27	29	28	38	33	27	--
		2	26	21	23	35	20	38	35	33	33	26
		3	31	25	22	38	25	50	37	30	35	29
FIRST HALF	Subject	1	20	14	8	14	12	13	19	27	18	--
		2	13	9	26	28	22	21	18	29	29	21
		3	20	8	11	7	11	27	24	16	28	16
SECOND HALF	Subject	1	29	24	38	41	49	42	56	38	37	--
		2	40	34	22	42	37	54	52	38	36	30
		3	43	41	33	70	39	73	49	43	42	41

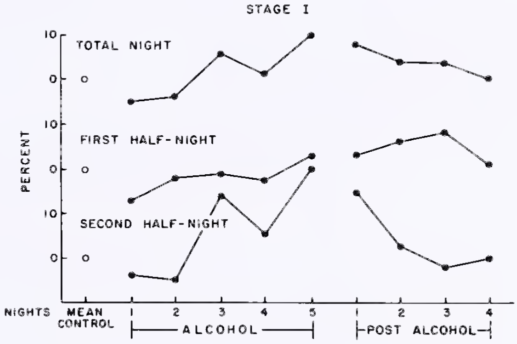
*average of two nights

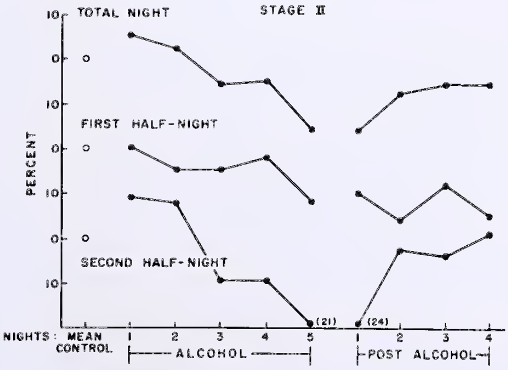
Figure 2 displays the mean time of each stage for all three subjects during the total night, first half night, and second half night throughout their consecutive nights of sleep. The lower right graph demonstrates how the change in length of REM periods approximates the change in mean REM time. Absolute numbers for each point are given in appendix table XV.


STAGE IV
TOTAL NIGHT
FIRST HALF-NIGHT
SECOND HALF-NIGHT
PERCENT
10
0
NIGHTS MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL


STAGE - AWAKE
TOTAL NIGHT
FIRST HALF-NIGHT
SECOND HALF-NIGHT
PERCENT
10
0
NIGHTS MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL


STAGE III
TOTAL NIGHT
FIRST HALF-NIGHT
SECOND HALF-NIGHT
PERCENT
10
0
NIGHTS MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL


STAGE I
TOTAL NIGHT
FIRST HALF-NIGHT
SECOND HALF-NIGHT
PERCENT
10
0
NIGHTS MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL


TOTAL NIGHT
STAGE II
FIRST HALF-NIGHT
SECOND HALF-NIGHT
PERCENT
10
0
(21)
(24)
NIGHTS: MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL

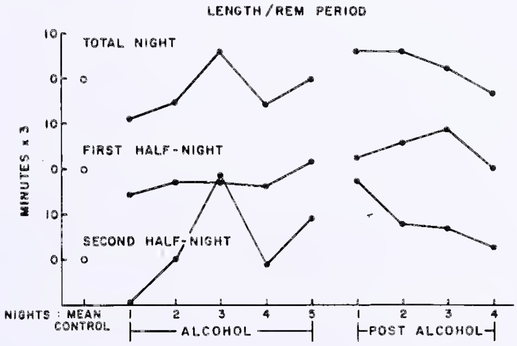
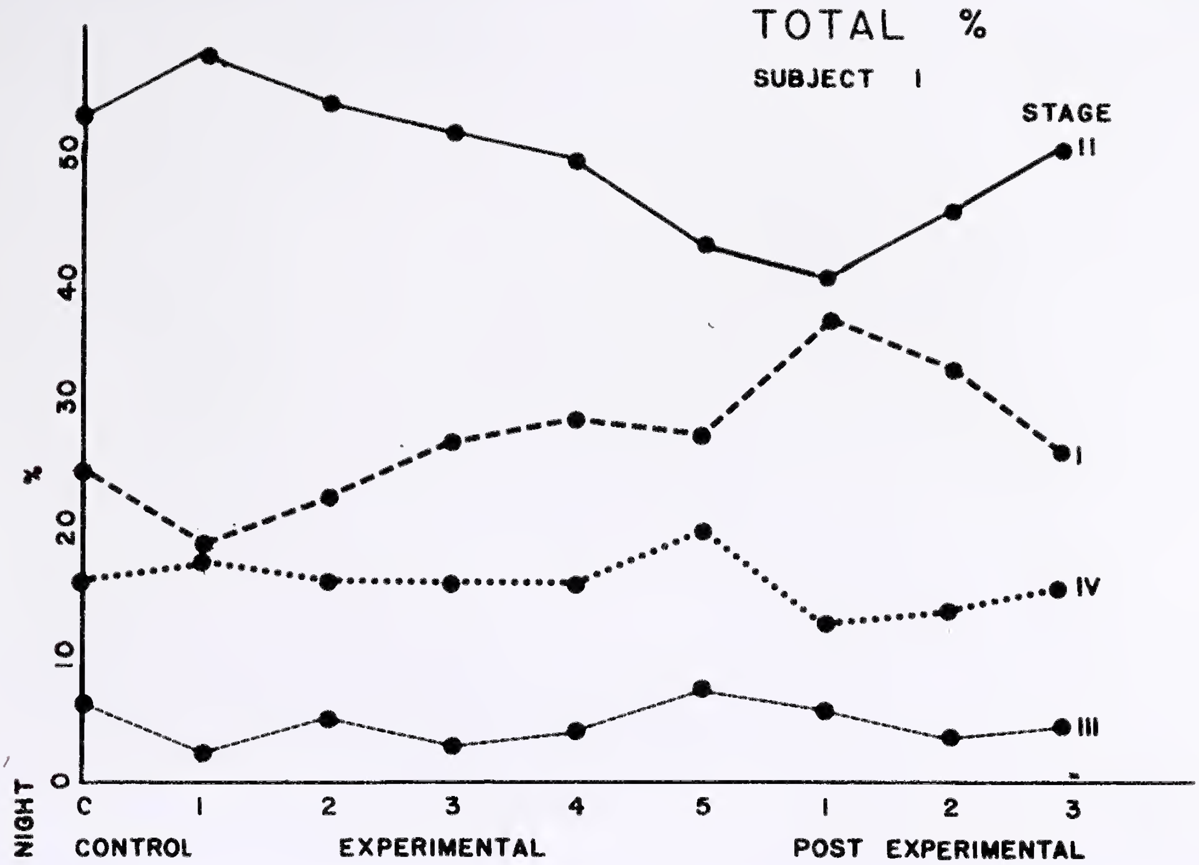

LENGTH/REM PERIOD
TOTAL NIGHT
FIRST HALF-NIGHT
SECOND HALF-NIGHT
MINUTES x 3
10
0
NIGHTS: MEAN CONTROL
1 2 3 4 5
ALCOHOL
1 2 3 4
POST ALCOHOL

Figure 3 shows the change in all stages for the total experiment in a representative subject. Note the reciprocal shifts in Stage I and Stage II.

Graphs for the total night and each half of the night for each subject are in the appendix.

Figure 4 shows the course of all stages during the second half of the night for the same subject shown in Figure 3. Note how the shifts seen in the total night are more pronounced in the second half of the night as blood alcohol levels decrease.


TOTAL %
SUBJECT I
STAGE
II
I
IV
III
%
50
40
30
20
10
0
NIGHT
C
1
2
3
4
5
1
2
3
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

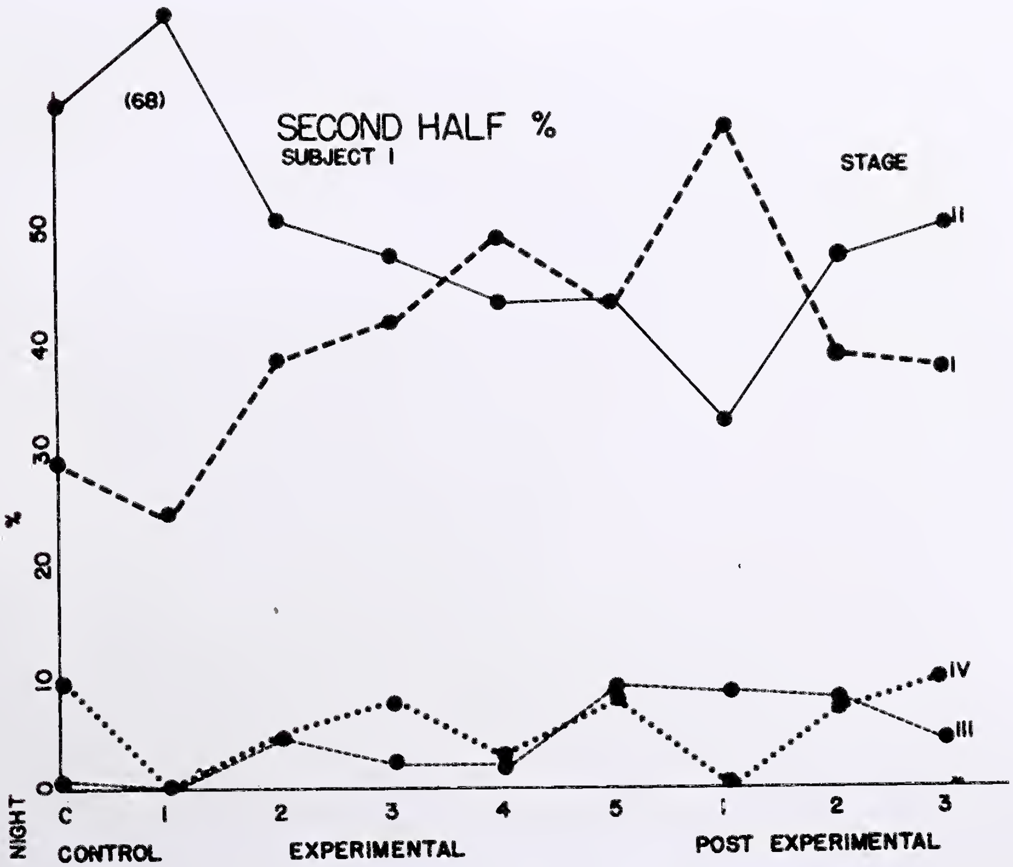

(68)
SECOND HALF %
SUBJECT I
STAGE
II
I
IV
III
%
50
40
30
20
10
0
NIGHT
C
1
2
3
4
5
1
2
3
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

TABLE II

LATENCY

(to first REM greater than 50 µV)

NIGHTS		CONTROL	ALCOHOL					POST-ALCOHOL			
		MEAN*	1	2	3	4	5	1	2	3	4
Subject 1	MINUTES	112	100	175	182	93	93	119	91	128	
	NUMBER OF STAGE SHIFTS	8	9	8	7	9	10	9	6	8	
Subject 2	MINUTES	150	197	81	90	81	96	179	182	128	176
	NUMBER OF STAGE SHIFTS	14	15	12	6	7	12	21	13	19	14
Subject 3	MINUTES	57	94	79	167	156	163	57	64	52	58
	NUMBER OF STAGE SHIFTS	7	11	8	13	12	13	5	4	5	8

*average of two nights

DISCUSSION

It might be expected that the major influence of alcohol would be at the time of its highest concentration or during the first half of the night; accordingly the data was analyzed not only for the total night, but also separately for the first and second halves of the night. This type of analysis is further suggested by experiments which show that alcohol in doses used here decreases body temperature in the first half of a night's sleep while increasing the temperature during the second half of the night (75). Interpretation of such data depends upon whether or not alcohol absorption and metabolism in sleep and wakefulness would be the same. Data suggestive of this are that gastric motility (76), gastric secretion (77), intestinal movements and urine formation (8) are not decreased by sleep, any residual alcohol left in the gastrointestinal tract at the onset of sleep should threrfore be rapidly and normally absorbed. Furthermore basal metabolic rate does not always decrease in sleep and oxygen consumption may not decrease in sleep (78) or may decrease only 10% (79);

thus one may assume that alcohol metabolism curves of man awake may be applied to this sleep experiment. These curves as well as studies by the author indicate that the blood alcohol concentrations produced in our subjects (85 - 105 mg%) would decrease to 50 mg% by half way through the night (80, 81, 82). When this level is reached from a higher blood alcohol concentration neither physiological nor psychological inebriation can be demonstrated (83). Therefore one expects changes observed during the first half of the night to be taking place when blood alcohol concentrations are highest and exerting their most powerful direct effects; changes seen during the second half of the night will be those occurring under less direct alcohol effect.

Changes occurring during the first half of the night, while blood alcohol concentrations were highest, include marked disruption of the normal latency time to the first REM and an alteration of Stage I REM time. The latency varied differently in each subject during alcohol nights and unlike the changes produced by amphetamine followed no systematic pattern during the first half of the night.

REM time decreased from control levels on the first alcohol night and on the following alcohol nights gradually increased over four nights to a level greater than control levels on the fifth alcohol night. When alcohol administration was stopped, REM time continued to increase on the first recovery night, remained increased for two more recovery nights, and returned to control levels by the fourth recovery night.

Changes which occurred during the second half of the night are similar to those which occurred during the first half of the night. REM time initially decreased from control levels on the first two alcohol nights only to increase above control levels on the last three alcohol nights, an increase greater than that seen during the first half of the night. During the second half of the night, however, REM time returned to control levels on recovery nights and was unlike the elevated REM time seen during the first half of recovery nights. Therefore as demonstrated in Figures 2 and 3, the change in REM seen from night to night occurs on alcohol nights largely in the second half of the night, when blood alcohol concentrations are lower; but the increases of REM time seen on recovery or non-alcohol nights occur

during the first half of the night when alcohol concentrations were highest on previous nights.

It is clear that ethyl alcohol exerts its effect by acting on mechanisms which regulate the duration of sleep stages and not the number of sleep stages; however, it is not so clear what type of mechanism is affected. Alcohol may be acting directly to suppress REM time as seen on the first alcohol night. The increase in REM time seen on following alcohol nights would then be due to some portion of the CNS overcoming or "escaping" direct alcoholic depression or habituating. This is supported by the fact that the resultant of the proposed habituation presents more markedly at low alcohol concentrations or during the second half of the night. On the other hand alcohol may act directly to stimulate REM time. The decrease in REM time seen on the first alcohol night would then be explained as due to a center initially refractory to alcohol or initial intrinsic dampening. Whatever the mechanism, the unique effect of alcohol accounts for the increase in REM time above that expected from the amount of deprivation, an increase which takes place when alcohol is present as well as after its removal. It is apparent that this increase in REM

is contingent upon the as yet unique effect of alcohol which affects the sleep rhythm but whose mechanism is dependent on greater than a single dose.

The central nervous system structures upon which alcohol acts are unknown, but its action on the reticular formation structures may be important if the following related evidence is considered. The reticular activating system has been implicated as the site of action of several drugs including amphetamine in cats (84, 85, 86). Bilateral muclei located in the reticular area are essential for both initiation of and inhibition of REM sleep (66, 67, 68, 69). Drugs which can produce effects on REM sleep (e.g. amphetamine) act in the area where nuclei necessary for REM sleep exist; alcohol may act on a similar area and possibly on the nuclei themselves. Since this author has recently demonstrated that cat sleep stages are affected by alcohol in a similar way to that reported here in humans (87), perhaps the mechanism of action of alcohol is the same in cats and in humans. These results indicate that alcohol affects mechanisms regulating sleep stages through an action which is dependent on serial dosage, and it is speculated through effects on brain stem mechanisms.

In addition to theoretical implications, these results suggest approaches to several clinical problems. Alcoholics in delirium tremens may spend between 80 - 100% of their sleep time in REM sleep (88). In view of these results experiments should be undertaken with chronic alcoholics, alcoholics suffering from mild withdrawal symptoms, and alcoholics in delirium tremens to determine whether mechanisms governing sleep stages differ because of the effect of chronic alcohol intake.

SUMMARY

This study indicates that 1 g of ethyl alcohol per Kg of body weight administered before sleep exerts a systematic effect on EEG sleep patterns. In three human subjects over 13 consecutive nights (4 control, 5 alcohol, and 4 recovery nights), the most consistent pattern of change from night to night was seen in Stage I REM. On the first night of alcohol the mean REM time dropped from the mean control value and over the next four consecutive nights on EtOH increased steadily to a peak value on the fifth night of alcohol. In four recovery nights REM time dropped back to control levels. This change in REM occurs in the first half of the night, when CSF alcohol levels are at their maximum concentration, and during the second half of the night. Latency or time to the first REM is constant in control and post-alcohol nights but varies unsystematically during nights of alcohol administration. Stages III and IV remain constant while Stage II "absorbs" the shifts demonstrated in Stage I.

APPENDIX

INTRODUCTION

Certain methods and results have been omitted from the text of this thesis in order to make it more readable and in order to present only data which could be discussed in terms of present day knowledge. Impressed with the lack of clarity of procedure and the absence of supposedly bulky or unusable data in many scientific papers, the author would include this appendix for other investigators who might have need for more complete methodology and results. This information is presented herein, respectively in parts A and B.

APPENDIX CONTENTS

PART A: Methodology

- I Electrodes
- II EEG Scoring

PART B: Results

- I For each Subject
- II For each Modality or Stage
- III Common to all Subjects

APPENDIX ABBREVIATIONS:

C: control or nights on which no alcohol was administered. The values in the tables are the means of two nights.

X: experimental or alcohol nights on which alcohol was administered. X nights total five in all subjects.

PX: post experimental, post alcohol, or recovery nights on which no alcohol was administered, but which immediately followed alcohol nights.

St: stage

PART A

I Electrodes

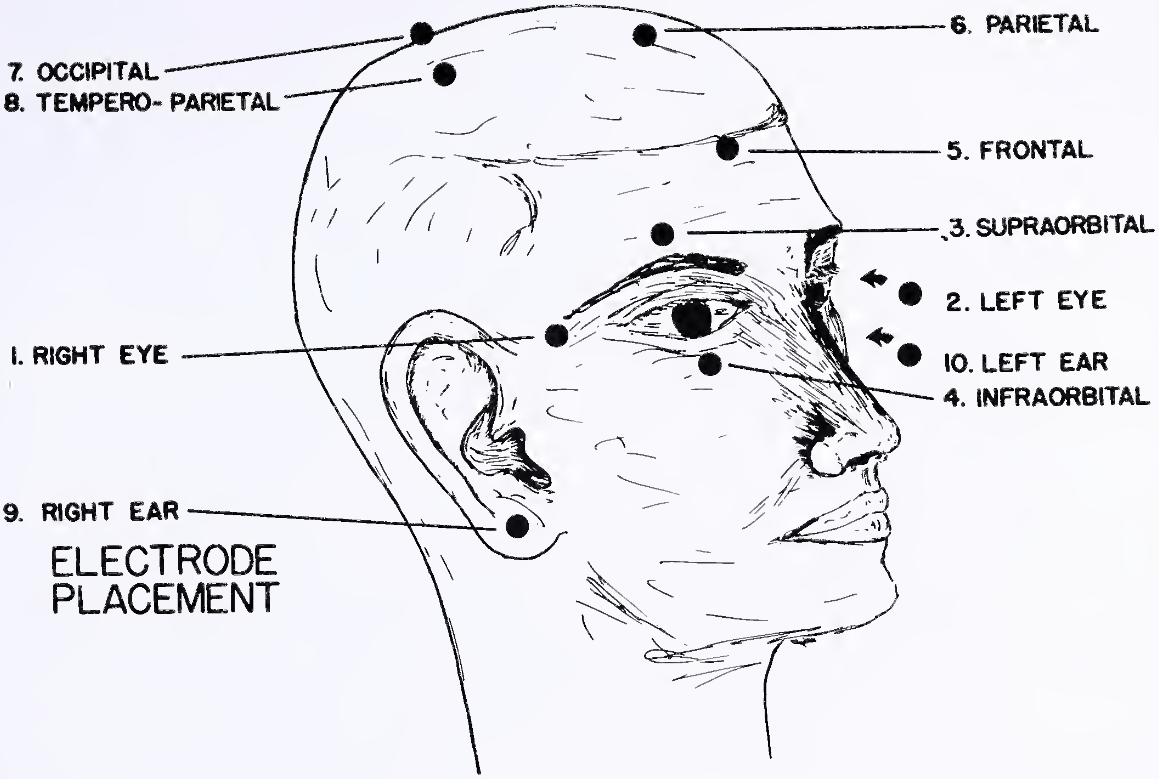
The technique for applying electrodes, the type of electrodes used, and an International System for placement of the electrodes is described in the text. However, since the EEG records were so satisfactory and the electrodes' placement so permanent, the author feels this an indication for a photographic representation of electrodes in place and their connections in order to facilitate the same for future investigators.

FIGURE 6

Text Figure 1 is here reproduced to allow comparison of this schematic diagram with the following three photographs of actual electrode placement.

FIGURE 7

Figure 7, 8, and 9 show electrode placement, the amount of cotton used for scalp electrodes, the positioning of tape attaching the electrode wires, and the amount of slack left in the electrode leads.



ELECTRODE PLACEMENT

FIGURE 8

FIGURE 9

FIGURE 10

Figure 10 shows the positioning of the connector box into which the electrode pins were attached; this positioning permitted the subject freedom of movement, especially freedom to turn without interfering with the EEG recording.

PART A

II EEG SCORING

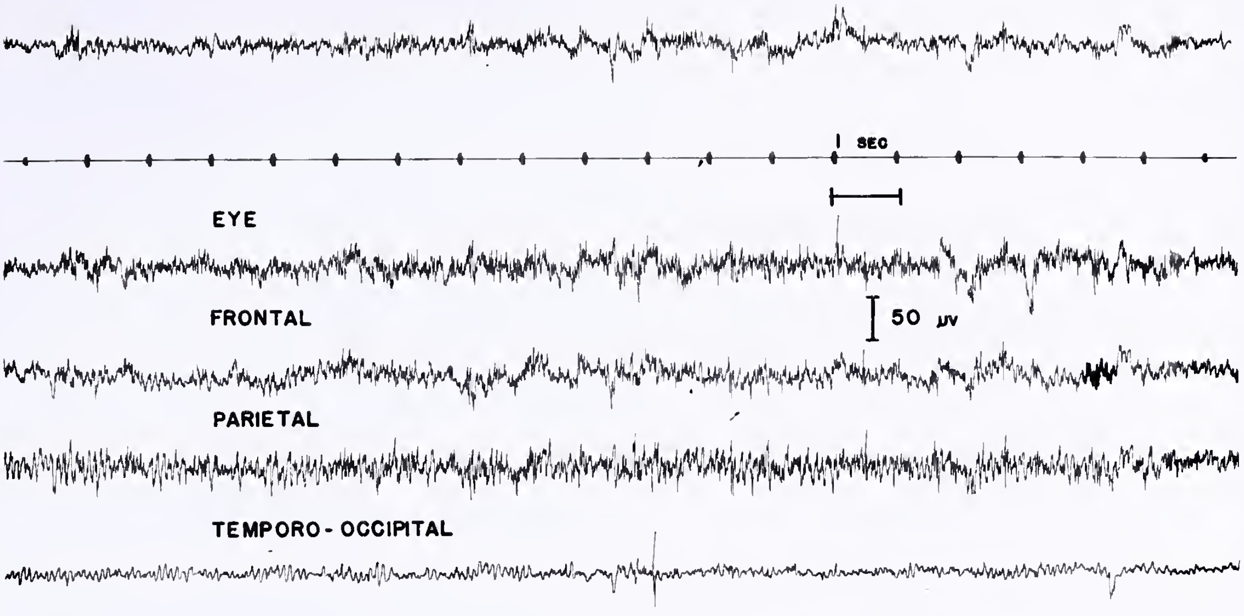
Although the criteria for EEG scoring are set down dogmatically and in a seemingly clear-cut fashion, there is evidence that different investigators score EEG records differently while using the same criteria. The criteria used here were set-up by Dement (1958) who taught them to Dr. K. A. Chandler; Dr. Chandler in turn taught the author and one other medical student, David Law, to score. These three investigators scored the same seven total night records blindly; an analysis of individual random pages revealed an interscorer reliability of only 60-75%; yet intrascorer reliability or the ability to reproduce one's own scoring was over 90%. Therefore rather than depend upon a verbal description of EEG patterns, of which Dement's criteria is composed, the following photographs of EEG sleep stage patterns are enclosed so that there can be no doubt to which type of EEG pattern this author ascribed his sleep stages.

FIGURE 11

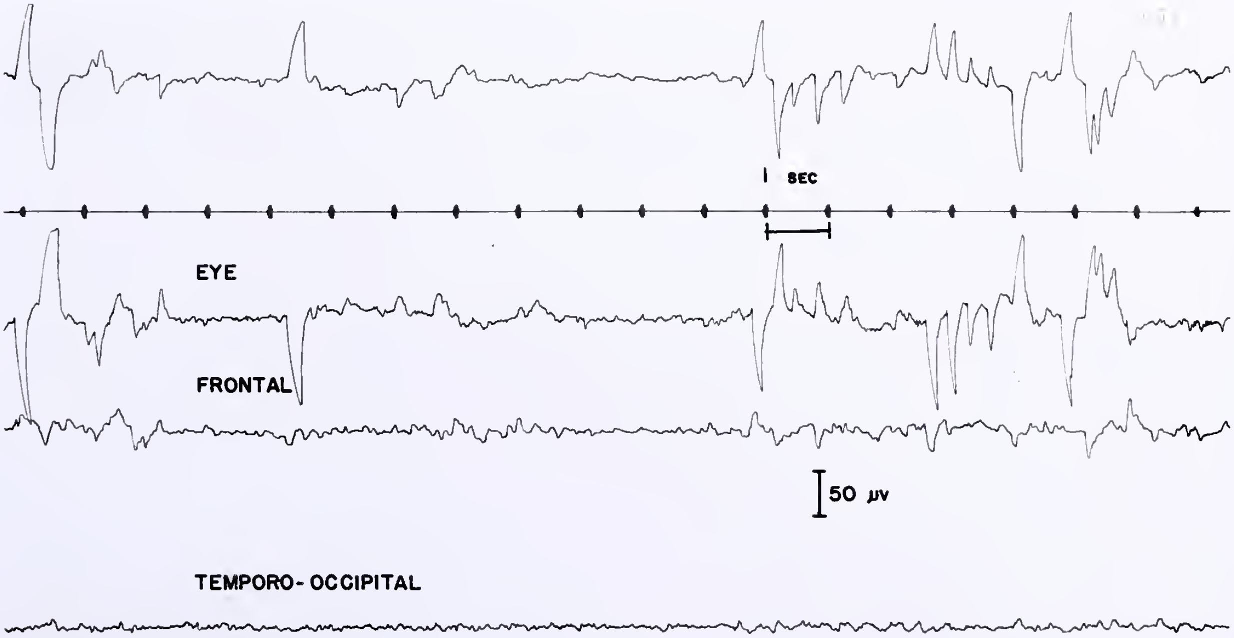
The EEG record in Figure 11 is scored as AW (awake) because of the fast activity seen in all leads, the 8-13/cycle activity seen best in the temporo-occipital lead, and the superimposed muscle spindling seen on the top four channels.

FIGURE 12

The EEG record in Figure 12 is scored as Stage I REM because of the conjugate eye movement tracings seen in the top two eye leads and the accompanying flat cortical tracings.



LEADS STAGE AW



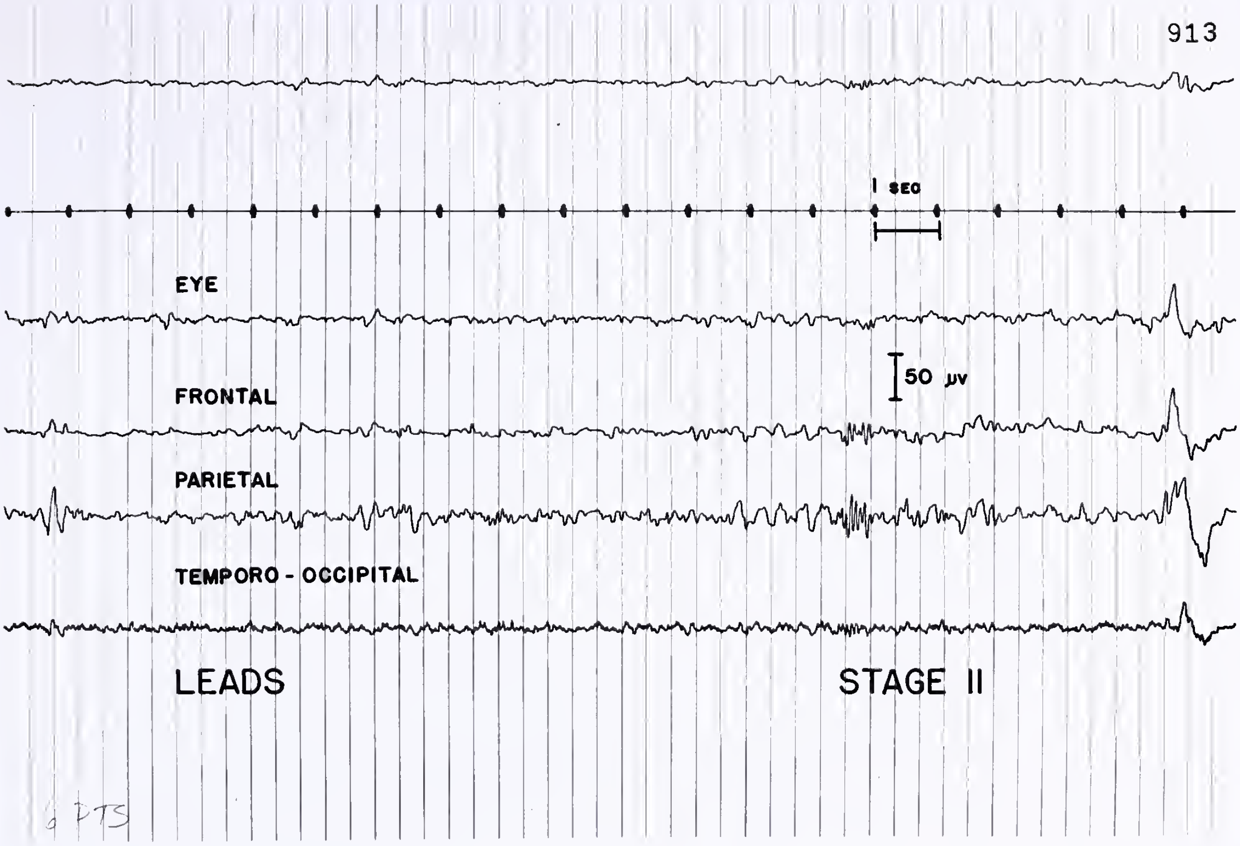
LEADS STAGE I

FIGURE 13

The EEG record in Figure 13 is scored as Stage II because of the presence of one spindle and one K complex; the same scoring would be applied if either two spindles and/or two K complexes or more were seen.

FIGURE 14

The EEG record in Figure 14 is scored as Stage III because more than three delta waves (seen best in the frontal and parietal leads) but less than one half page are present.


913
1 SEC
EYE
50 µv
FRONTAL
PARIETAL
TEMPORO - OCCIPITAL
LEADS
STAGE II
PTS

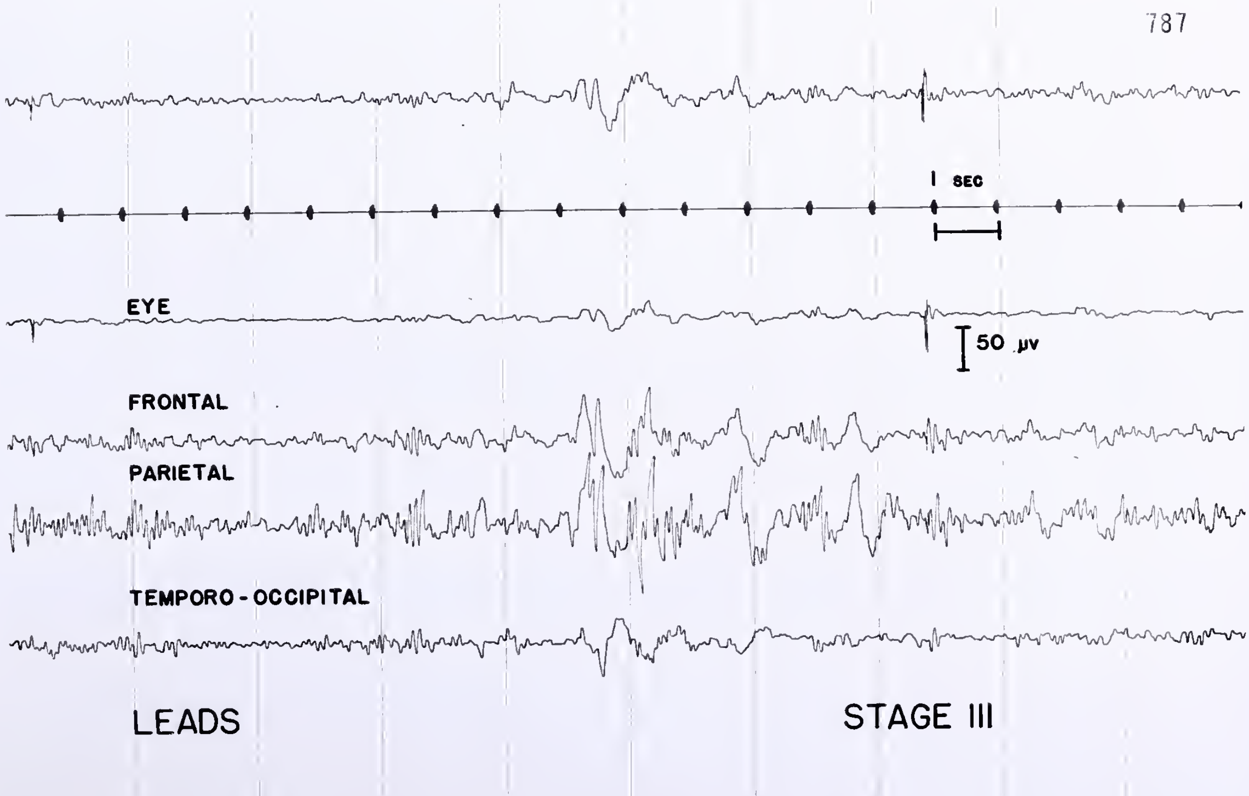
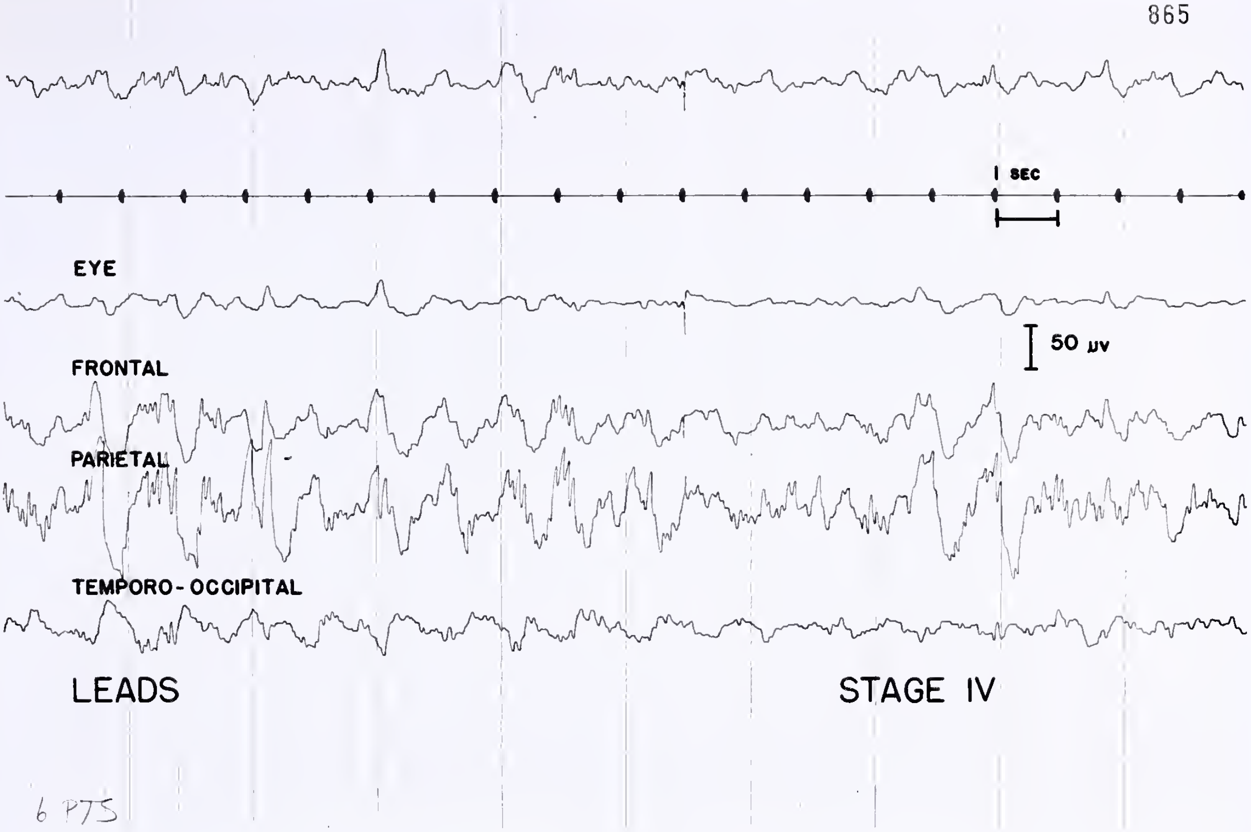

787
1 SEC
EYE
50 µv
FRONTAL
PARIETAL
TEMPORO - OCCIPITAL
LEADS
STAGE III

FIGURE 15

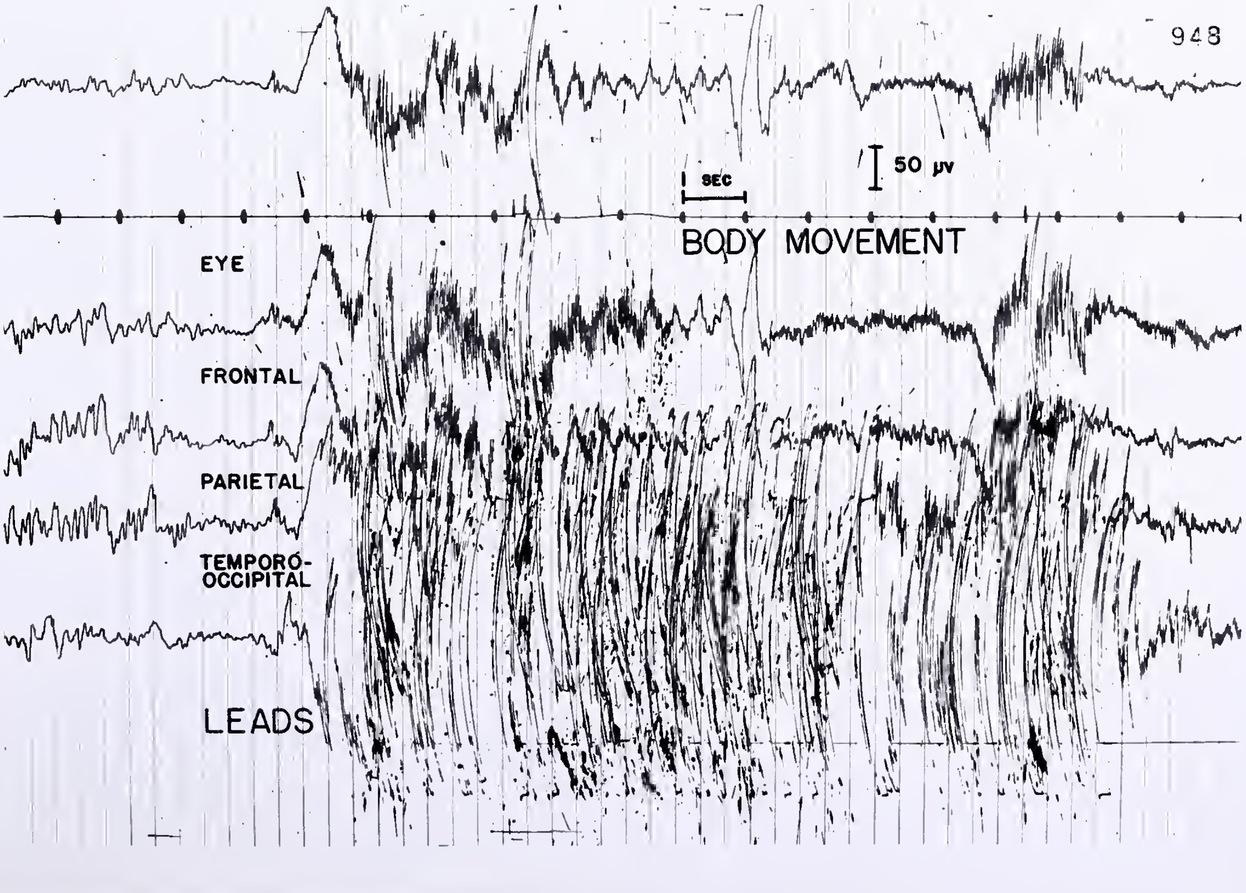
The EEG record in Figure 15 is scored as Stage IV because greater than one half page of delta waves are present.

FIGURE 16

The EEG record in Figure 16 is scored as a body movement (BM) because greater than one half page of extensive muscle spindling is seen in all leads.


865
1 SEC
EYE
50 μv
FRONTAL
PARIETAL
TEMPORO-OCCIPITAL
LEADS
STAGE IV

6 PTS


948
50 μv
1 SEC
BODY MOVEMENT
EYE
FRONTAL
PARIETAL
TEMPORO-OCCIPITAL
LEADS

PART B

RESULTS

The data is divided into total nights, first ½ nights, and second ½ nights for each of the three subjects; further analysis includes percent of time in each stage, number of stage shifts, pages of body movements (BM), and latency time to the first REM. For the convenience of the reader, the results of these data are presented in three steps:

I. an analysis of each subject,

II. an analysis of each stage or modality, and

III. a composite summary of data common to all subjects and/or stages which leads to immediate conclusions.

I. AN ANALYSIS OF EACH SUBJECT

Subject 1 (table III - VI), Figures 17-19

Observation of subject one's data indicates the following:

Total Night

1. The per-cent of time spent in AW is greater in experimental (alcohol or X) and post-experimental (PX) nights.
2. ST I decreases below control (C) levels on X-1 and increases steadily to exceed control levels on X-5; becoming higher on PX-1, St I decreases toward C levels on the succeeding nights.
3. St II increases on X-1 and then steadily decreases from X-1 through X-5, reaching its low in PX-1 (when St I is at its high) and returning toward C levels during the remaining PX nights.
4. St IV is highest on X-1, the first alcohol night as well as on X-5, when the dosage of alcohol was increased.
5. St III and IV remain constant, reaching a high only in the high-dose alcohol night.
6. Number of stage shifts and number of body movements (BMs) are constant.
7. Most of the total night is spent in St II.

Subject 1

Observation of subject one's data indicates the following:

First Half Night

1. The per-cent of time spent in AW is greater on PX nights.
2. St I in PX nights exceeds St I in X nights by 5 %.
3. St II is higher in X nights but below X and C levels in PX nights.
4. St IV as well as St III and IV are higher on X nights.
5. BMs and number of shifts are decreased on X nights.
6. Most of the first half time is spent in St II.

Subject 1

Observation of subject one's data indicates the following:

Second Half Night

1. The subject was AW in all X nights, but in no C night, and only in one PX night.
2. St I decreases from C levels to X-1 and then increases through X-4 (X-5 decreasing with an excess alcohol dose) to peak on PX-1 and decrease toward control levels.
3. St II increases from C to X-1 and then decreases through X nights reaching a low on PX-1 and increasing toward control levels.
4. There are more stage shifts on X nights.
5. Most of the second half time is spent in St II or St I.

TABLE III

SUBJECT NUMBER 1: CONSECUTIVE NIGHTS

NIGHT	CONTROL	EXPERIMENTAL					POST-EXPERIMENTAL		
		1	2	3	4	5	1	2	3
JUICE (ml)	400	400	400	400	400	400	400	400	400
EtOH (ml)	120	120	120	120	120	180	-	-	-
TOTAL TIME (seconds)	28,540	28,980	28,360	28,740	28,990	28,800	28,640	28,820	28,800
STAGE AW	100	1,020	460	280	460	220	560	800	220
I	6,860	5,540	6,560	7,900	8,380	7,840	10,760	9,400	7,860
II	15,260	16,760	15,280	14,820	14,820	12,540	11,800	13,200	14,780
III	1,720	520	1,480	1,000	1,120	2,240	1,660	1,260	1,340
IV	4,600	5,180	4,580	4,740	4,760	5,900	3,860	4,160	4,600
III & IV	6,320	5,700	6,060	5,740	5,880	8,140	5,520	5,420	5,940

TABLE IV

SUBJECT NUMBER 1: CONSECUTIVE NIGHTS

	NIGHT	CONTROL	EXPERIMENTAL					POST-EXPERIMENTAL		
			1	2	3	4	5	1	2	3
FIRST HALF	TOTAL TIME (seconds)	14,300	14,520	14,180	14,360	14,480	14,400	14,320	14,420	14,400
	STAGE AW	100	60	0	0	100	220	200	800	220
	I	2,800	2,100	1,200	1,940	1,680	1,760	2,760	3,880	2,600
	II	6,640	6,660	8,240	8,100	7,580	6,360	7,140	6,420	7,580
	III	1,580	520	800	660	800	900	360	100	820
	IV	3,180	5,180	3,940	3,660	4,320	4,740	3,860	3,220	3,180
	III & IV	4,760	5,700	4,740	4,320	5,120	5,640	4,220	3,320	4,000
SECOND HALF	TOTAL TIME (seconds)	14,240	14,480	14,180	14,380	14,510	14,400	14,320	14,400	14,400
	STAGE AW	0	940	460	280	360	0	360	0	0
	I	4,060	3,440	5,360	5,960	7,100	6,060	8,000	5,520	5,360
	II	8,620	10,100	7,040	6,720	6,290	6,180	4,660	6,780	7,200
	III	140	0	680	340	320	1,340	1,300	1,160	520
	IV	1,420	0	640	1,080	440	1,160	0	940	1,420
	III & IV	1,560	0	1,320	1,420	760	2,500	1,300	2,100	1,940

TABLE V

PERCENTAGE

SUBJECT NUMBER 1: CONSECUTIVE NIGHTS

	NIGHT	CONTROL	EXPERIMENTAL					POST-EXPERIMENTAL		
			1	2	3	4	5	1	2	3
TOTAL	STAGE AW	0.3	3.5	1.6	0.9	1.5	0.7	1.9	2.7	0.8
	I	24.0	19.1	23.1	27.4	28.9	28.0	37.5	32.6	27.2
	II	53.4	57.8	53.8	51.5	49.2	42.8	41.2	45.9	51.3
	III	6.0	1.8	5.2	3.4	3.8	8.0	5.7	4.3	4.6
	IV	15.9	17.8	16.1	16.4	16.4	20.1	13.4	14.4	15.9
	III & IV	22.0	19.6	21.3	19.8	20.2	28.1	19.1	18.7	20.5
FIRST HALF	STAGE AW	0.6	0.4	0	0	0.6	1.5	1.3	5.4	1.5
	I	19.5	14.4	8.4	13.5	11.6	12.5	19.2	26.9	18.0
	II	46.4	45.8	58.1	56.4	52.3	45.4	49.8	44.5	52.6
	III	11.0	3.5	5.6	4.5	5.5	6.4	2.5	0.6	5.6
	IV	22.2	35.6	27.7	25.4	29.8	33.9	26.9	22.3	22.0
	III & IV	33.2	39.1	33.1	29.9	35.3	40.3	28.4	22.9	27.6
SECOND HALF	STAGE AW	0	6.4	3.2	1.8	2.4	0	2.5	0	0
	I	28.5	23.7	37.7	41.4	48.9	42.0	55.8	38.3	37.2
	II	60.5	69.7	49.6	46.7	43.3	42.9	32.5	47.0	50.0
	III	0.9	0	4.7	2.3	2.2	9.3	9.0	8.0	3.6
	IV	9.9	0	4.5	7.5	3.0	8.0	0	6.5	9.8
	III & IV	11.0	0	9.2	9.8	5.3	17.3	9.0	14.5	13.4

TABLE VI

SUBJECT NUMBER 1: CONSECUTIVE NIGHTS

NIGHT	CONTROL	EXPERIMENTAL					POST-EXPERIMENTAL		
		1	2	3	4	5	1	2	3
NUMBER OF STAGE SHIFTS									
TOTAL NIGHT	24	22	19	19	30	28	23	27	21
FIRST HALF	16	15	10	9	16	17	15	14	15
SECOND HALF	7	7	9	10	14	11	8	13	6
BODY MOVEMENTS (pages)									
TOTAL NIGHT	23	17	29	15	13	31	27	30	11
FIRST HALF	12	7	10	9	7	16	18	16	7
SECOND HALF	11	10	19	6	6	15	19	14	4
LATENCY (time to first REM of 50 uv)									
PAGES	335	300	526	547	280	280	358	273	383
MINUTES	112	100	175	182	93	93	119	91	128
NUMBER OF SHIFTS	8	9	8	7	9	10	9	6	8

FIGURE 17

Figure 17 shows the per-cent of sleep time subject 1 spent in each stage for the total night.

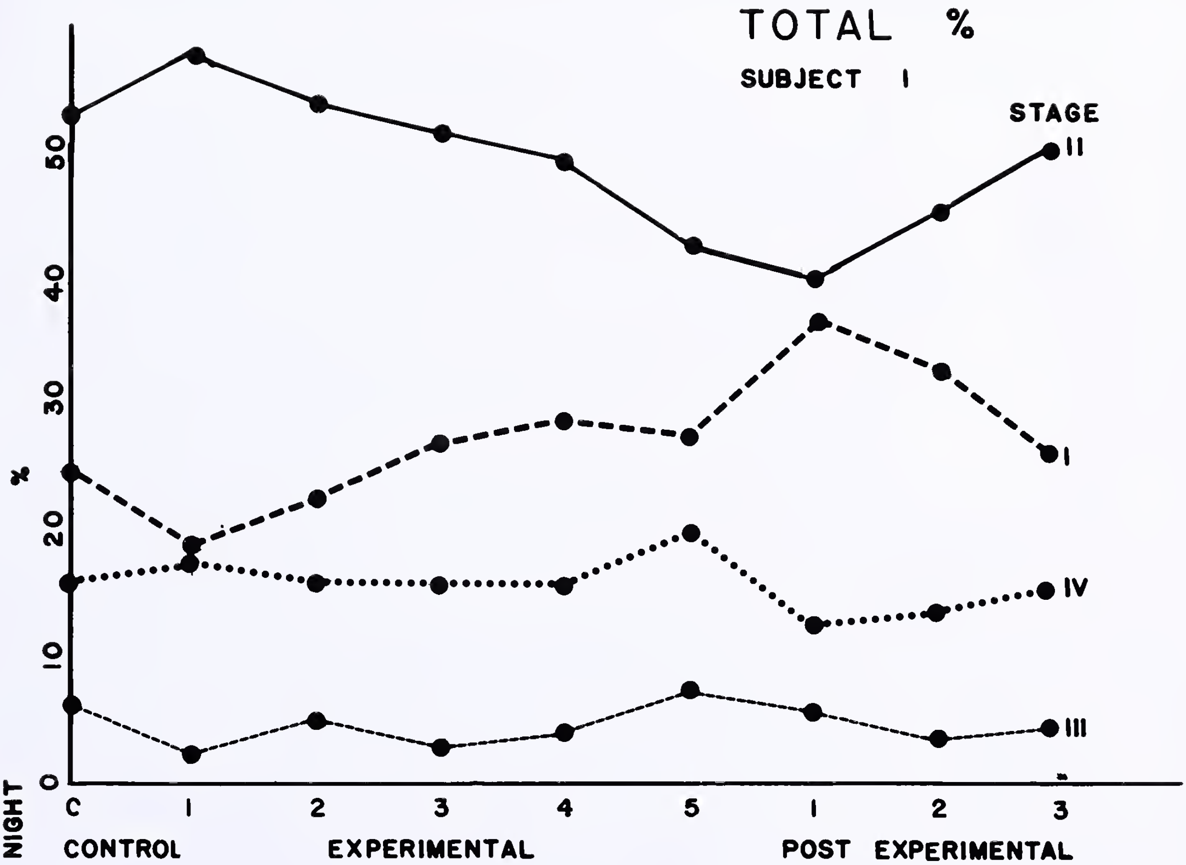
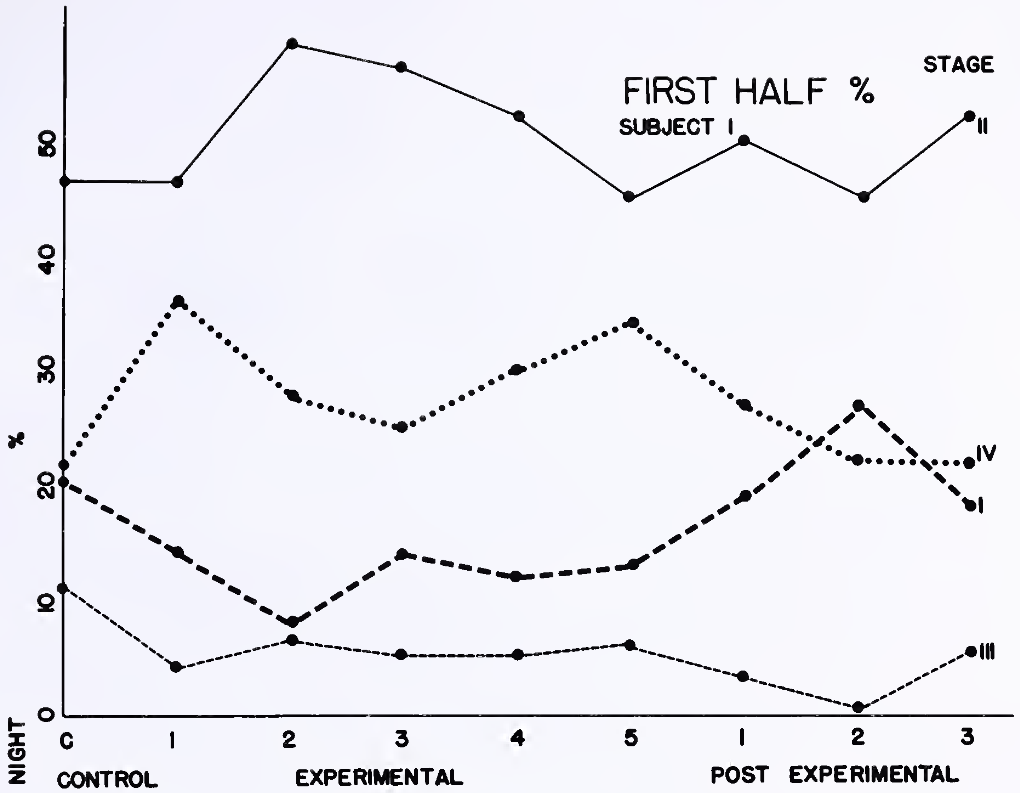

TOTAL %
SUBJECT I
STAGE
II
I
IV
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

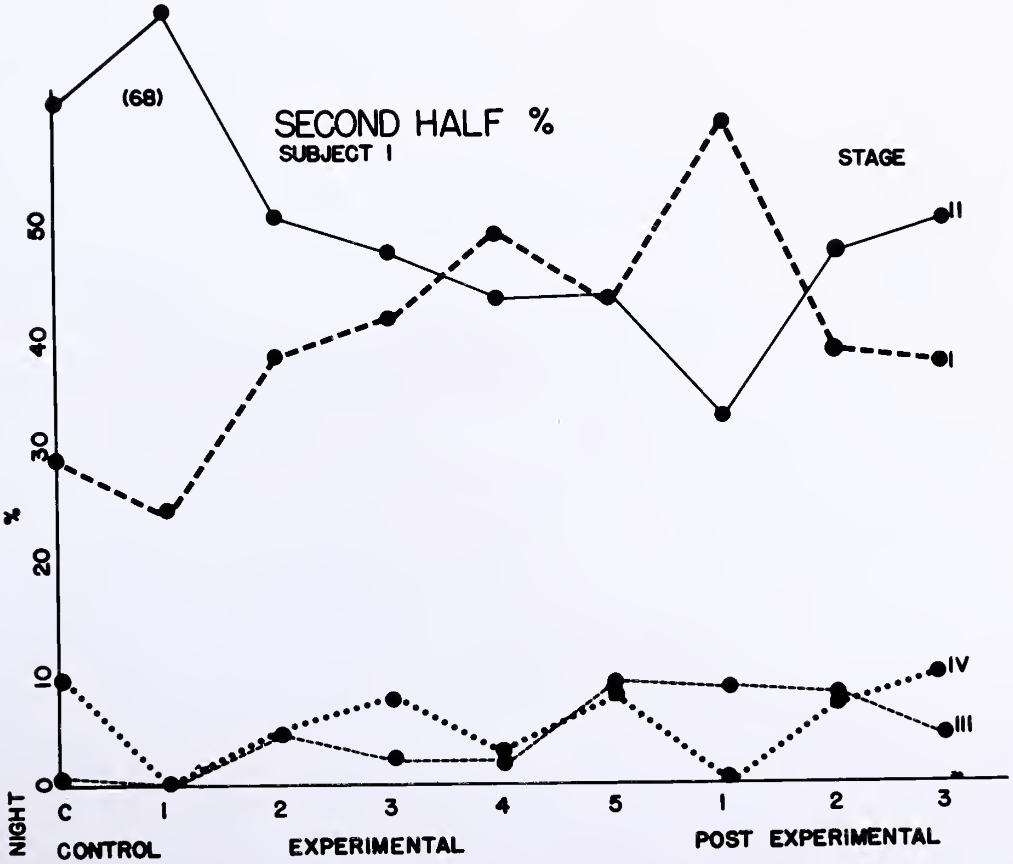
FIGURE 18

Figure 18 shows the per-cent of sleep time subject 1 spent in each stage for the first half night.

FIGURE 19

Figure 19 shows the per-cent of sleep time subject 1 spent in each stage for the second half night.


FIRST HALF %
SUBJECT 1
STAGE
II
IV
I
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL


SECOND HALF %
SUBJECT 1
(68)
STAGE
II
I
IV
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

Subject 2 (Table VII - X), Figures 20-22

Observation of subject two's data indicates the following:

Total Night

1. The per-cent of time spent in AW is greater in experimental nights.
2. St I decreases below C levels on X-1, increases steadily to exceed C levels and peak on X-5, and decreases to C levels on PX nights.
3. St II increases on X-1 and steadily decreases from X-2 through X-5, only to return toward control levels on the remaining PX nights.
4. St IV is not increased during X-1.
5. St III and IV remain constant.
6. There are more BMs on PX nights, but the number of stage shifts is the same on all nights.
7. Most of the total time is spent in St II or St I.

Subject 2

Observation of subject two's data indicates the following:

First Half Night

1. The per-cent of time in AW is less on PX nights.
2. St I is below C levels only in X-1 and is greater than C levels in all other X and PX nights.
3. St II is below C levels in all but the first X night.
4. St III and IV show no constant pattern.
5. BMs are decreased on X nights and increased on PX nights.
6. Most of the first half time is spent in St I or St IV.

Subject 2

Observation of subject two's data indicates the following:

Second Half Night

1. The subject was AW in most of the X nights, but never in a C or PX night.

2. The nights with the total night highest St I (X-3, 5, PX-1, 2) have highest St I values in the second half night.

3. St II is low when St I is high and vice-versa.

4. St III and IV show no consistent pattern but are high on X-4 when total night St I is decreased.

5. There are more stage shifts on alcohol nights.

6. Most of the time in the second half is spent in St II or St I.

TABLE VII

SUBJECT NUMBER 2: CONSECUTIVE NIGHTS

NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
			1	2	3	4	5	1	2	3	4
JUICE (ml)	200	200	200	200	200	200	200	200	200	200	200
EtOH (ml)	-	-	90	90	90	90	90	-	-	-	-
TOTAL TIME (seconds)	25,500	25,500	25,500	25,280	25,080	25,360	25,380	25,400	25,220	25,240	25,300
STAGE AW	1,000	800	1,400	100	1,060	1,840	1,260	800	520	800	760
I	6,980	6,500	5,360	5,900	8,780	7,520	9,640	8,820	8,360	8,220	6,520
II	10,100	11,080	11,900	11,780	7,620	7,560	6,640	6,600	8,460	9,500	9,160
III	2,820	2,500	2,840	2,520	2,400	3,960	2,860	3,280	3,760	1,420	2,700
IV	4,600	4,600	3,880	4,980	5,260	4,480	4,980	5,820	4,100	5,300	6,160
III & IV	7,420	6,220	6,720	7,500	7,660	8,440	7,840	9,100	7,860	6,720	8,860

TABLE VIII

SUBJECT NUMBER 2: CONSECUTIVE NIGHTS

	NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
				1	2	3	4	5	1	2	3	4
FIRST HALF	TOTAL TIME (seconds)	12,750	12,750	12,710	12,640	12,540	12,640	12,700	12,660	12,580	12,640	12,680
	STAGE AW	1,000	880	560	100	840	1,600	1,260	800	520	800	760
	I	1,340	1,920	1,220	3,080	3,540	2,840	2,720	2,240	3,620	3,680	2,720
	II	4,340	5,100	5,040	2,800	1,680	3,360	3,160	3,680	1,540	3,500	3,140
	III	1,500	1,080	1,760	2,280	1,900	1,920	1,780	1,560	3,200	1,020	1,360
	IV	4,600	3,700	3,880	4,380	4,620	2,920	3,780	4,380	3,700	3,620	4,700
	III & IV	6,100	4,780	5,640	6,660	6,520	4,840	5,560	5,940	6,900	4,640	6,060
SECOND HALF	TOTAL TIME (seconds)	12,750	12,750	12,710	12,640	12,540	12,720	12,680	12,620	12,620	12,620	12,620
	STAGE AW	0	0	840	0	220	240	0	0	0	0	0
	I	5,640	4,520	4,140	2,820	5,240	4,680	6,920	6,580	4,740	4,540	3,800
	II	5,760	5,980	6,860	8,980	5,940	4,200	3,480	2,920	6,920	6,000	6,020
	III	1,320	1,420	1,080	240	500	2,040	1,080	1,720	560	400	1,340
	IV	0	900	0	600	640	1,560	1,200	1,440	400	1,680	1,460
	III & IV	1,320	2,320	1,080	1,040	1,140	3,600	2,280	3,160	960	2,080	2,800

TABLE IX

PERCENTAGE
SUBJECT NUMBER 2: CONSECUTIVE NIGHTS

	NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
				1	2	3	4	5	1	2	3	4
TOTAL	STAGE AW	4	3.5	5.4	0.9	3.8	7.2	4.9	3.1	2.0	3.1	3.0
	I	27	25.5	21.0	23.3	35.0	29.7	37.9	34.7	33.1	32.5	25.7
	II	40	43.4	46.2	46.0	30.5	29.7	26.1	25.9	33.5	37.6	36.2
	III	11	9.8	11.2	10.0	9.6	15.6	11.2	12.9	14.9	5.6	10.6
	IV	18	18.0	15.2	19.7	21.0	17.6	19.6	22.9	16.2	20.9	24.3
	III & IV	29	27.8	26.4	29.7	30.6	33.2	30.8	35.8	31.1	26.6	34.9
FIRST HALF	STAGE AW	5.5	6.9	4.4	0.7	6.7	12.6	9.9	6.3	4.1	6.3	5.9
	I	10.5	15.0	8.5	26.4	28.3	22.4	21.4	17.6	28.7	29.1	21.4
	II	36.9	40.0	39.6	22.1	13.4	26.5	24.8	29.0	12.2	27.6	24.7
	III	11.7	8.5	13.8	18.0	15.2	15.1	14.0	12.3	25.4	8.0	10.7
	IV	36.0	29.0	30.5	34.6	37.0	23.1	29.7	34.5	29.4	28.6	37.0
	III & IV	47.7	37.5	44.3	52.6	52.2	38.2	43.7	46.8	54.8	36.7	47.7
SECOND HALF	STAGE AW	0	0	6.6	0	1.7	1.8	0	0	0	0	0
	I	44.2	35.4	33.6	22.3	41.7	37.0	54.4	52.1	37.5	35.9	30.1
	II	45.1	46.9	54.0	71.0	47.3	33.0	27.4	23.1	54.8	47.5	47.7
	III	10.3	11.1	8.4	1.8	3.9	16.0	8.5	13.6	4.4	3.1	10.6
	IV	0	7.0	0	4.7	5.1	12.2	9.4	11.4	3.1	13.3	11.5
	III & IV	10.3	18.1	8.4	6.5	9.0	28.2	17.9	25.0	7.6	16.4	22.1

TABLE X

SUBJECT NUMBER 2: CONSECUTIVE NIGHTS

NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
			1	2	3	4	5	1	2	3	4
NUMBER OF STAGE SHIFTS											
TOTAL NIGHT	23	30	23	29	27	37	32	36	23	27	29
FIRST HALF	15	17	15	22	16	20	18	22	13	19	17
SECOND HALF	8	13	8	7	11	17	14	14	10	8	12
BODY MOVEMENTS (pages)											
TOTAL NIGHT	28	33	24	38	27	27	30	36	47	43	44
FIRST HALF	14	18	15	18	17	11	10	23	31	18	26
SECOND HALF	14	15	9	20	10	16	20	13	16	25	18
LATENCY (time to first REM of 50 uv)											
PAGES	347	555	592	243	270	243	289	537	547	443	527
MINUTES	116	185	197	81	90	81	96	179	182	128	176
NUMBER OF SHIFTS	11	17	15	12	6	7	12	21	13	19	14

FIGURE 20

Figure 20 shows the per-cent of sleep time subject 2 spent in each stage for the total night.

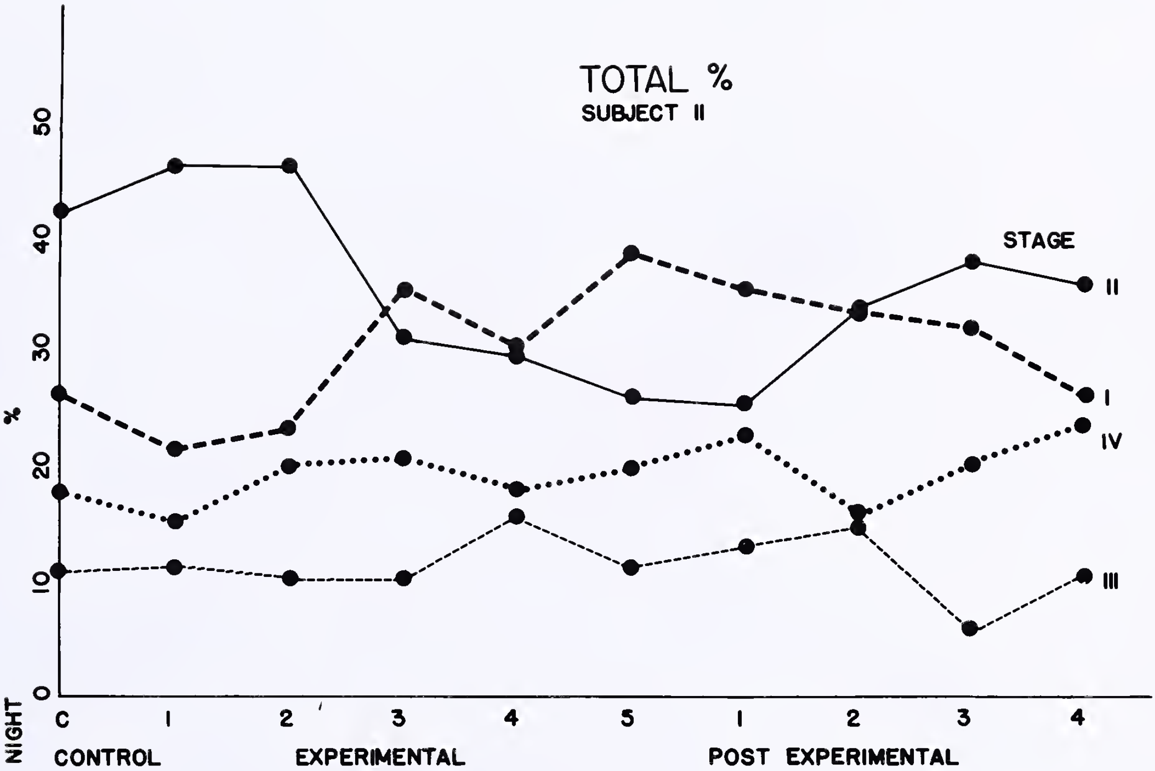
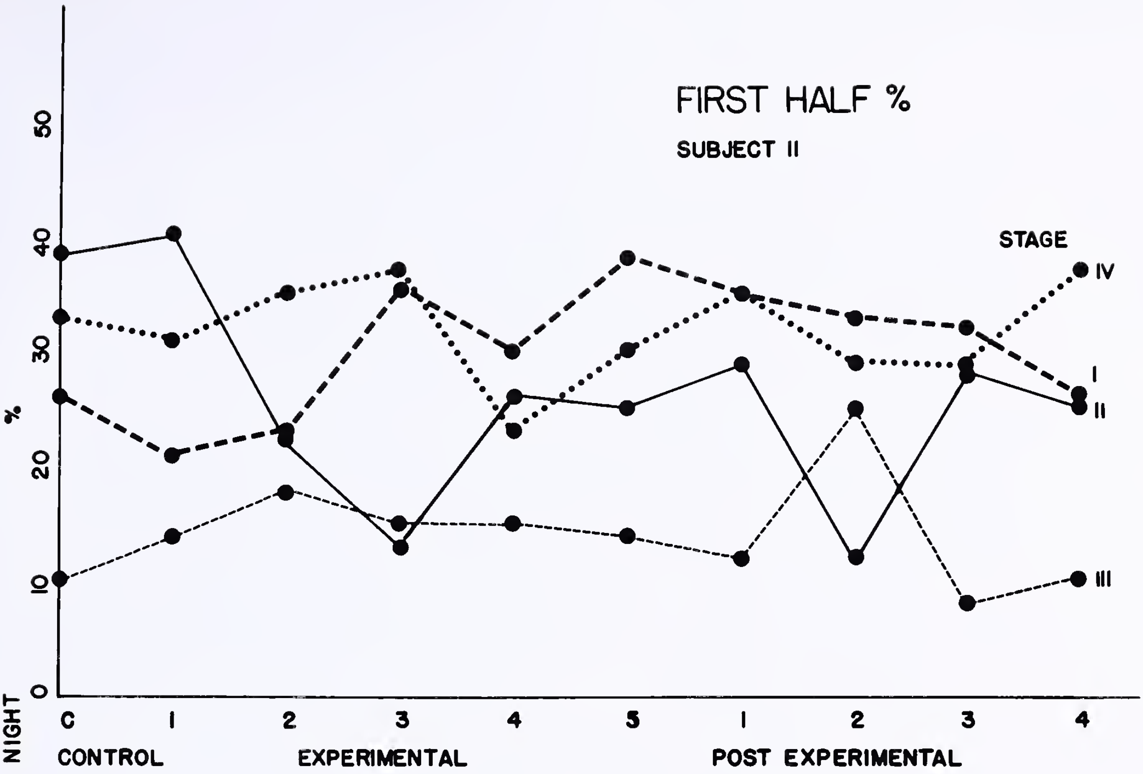

TOTAL %
SUBJECT II
STAGE
II
I
IV
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

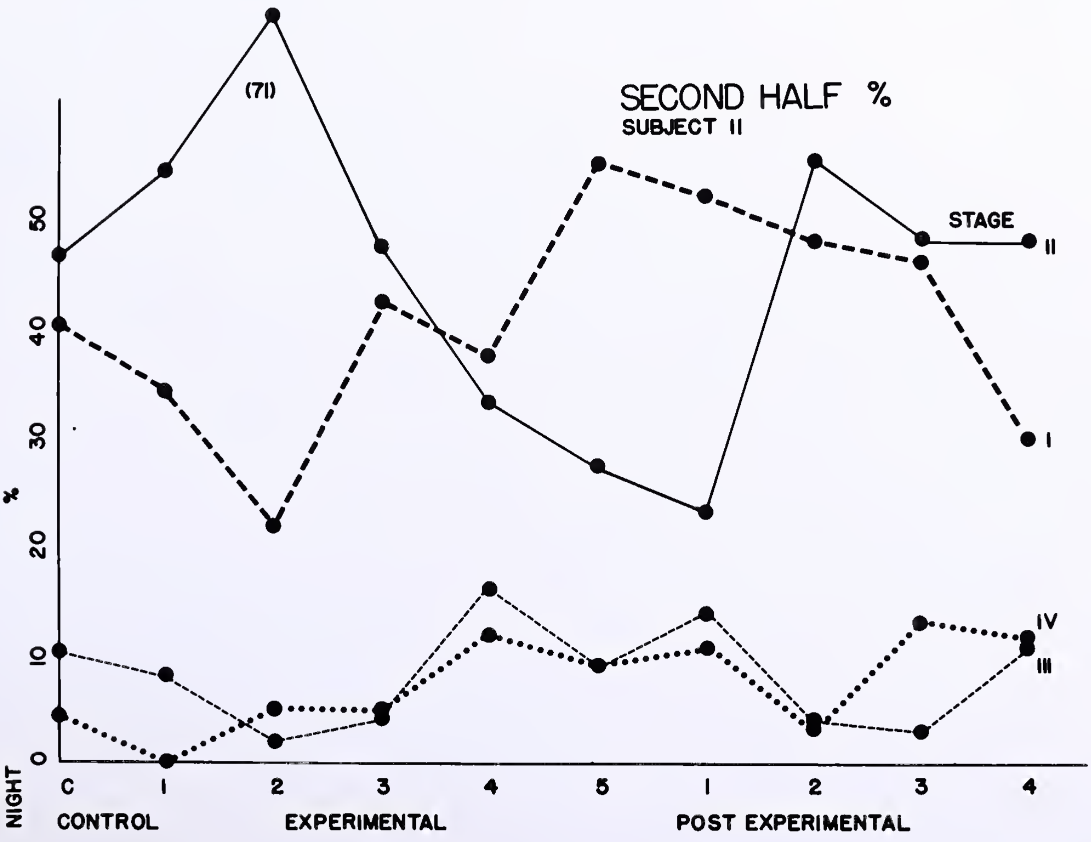
FIGURE 21

Figure 21 shows the per-cent of sleep time subject 2 spent in each stage for the first half night.

FIGURE 22

Figure 22 shows the per-cent of sleep time subject 2 spent in each stage for the second half night.


FIRST HALF %
SUBJECT II
STAGE
IV
I
II
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL


SECOND HALF %
SUBJECT II
(71)
STAGE
II
I
IV
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

Subject 3 (table XI - XIV), Figures 23-25

Observation of subject three's data indicates the following:

Total Night

1. The per-cent of time spent in AW is greater on X nights.
2. St I is erratic but decreases from C levels the first two X nights and then shifts up and down with a trend toward increasing, finally returning to C levels on the PX nights.
3. St II varies inversely with St I, also returning to C levels on the final PX night.
4. St III and IV show variability with no consistent pattern except for the steady decrease to C levels on the PX nights; more time is spent in St IV on the final X night and on PX nights.
5. There are fewer stage shifts on X nights.
6. Most of the total time is spent in St I or St IV.

Subject 3

Observation of subject three's data indicates the following:

First Half Night

1. The per-cent of time spent in AW is greater in X nights.

2. St I decreases from C levels during the first four X nights, exceeds C levels on X-5, and returns to C levels on PX nights. Mean St I during X nights is 12.5 % compared with C and PX values of 20%.

3. St II tends to the inverse of St I becoming lowest when St I reaches its high.

4. St III and IV vary and tend toward peak values when St I peaks on X and PX nights. Combined St III and IV values are highest (mean 62.8%) on PX nights.

5. BMs are decreased on X nights.

6. Most of the first half is spent in St IV.

Subject 3

Observation of Subject three's data indicates the following:

Second Half Night

1. The per-cent of time spent in AW is less than C levels in all other nights.
2. St I includes the tremendous peaks (greater than 70%) which occurred on the nights when the subject acted extremely inibriated; these peaks occur on the two X nights of high St I in the total night data.
3. The trend of St I is to decrease from C levels the first two X nights, increase on the following three X nights, and return to C levels during the PX nights.
4. St II varies inversely with St I.
5. St IV is increased on PX nights, as is St III and IV combined.
6. Most of the second half is spent in St I.

TABLE XI

SUBJECT NUMBER 3: CONSECUTIVE NIGHTS

NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
			1	2	3	4	5	1	2	3	4
JUICE (ml)	200	200	200	200	200	200	200	200	200	200	-
EtOH (ml)	-	-	100	100	100	100	100	-	-	-	-
TOTAL TIME (seconds)	25,240	25,260	24,760	25,160	25,460	25,220	24,880	25,060	25,080	24,620	25,320
STAGE AW	560	1,480	2,080	1,760	2,520	640	1,500	380	1,040	460	1,020
I	7,360	8,560	6,180	5,580	9,800	6,320	12,380	9,180	7,420	8,600	7,240
II	7,980	8,020	9,220	8,400	6,280	8,440	2,600	2,860	5,280	4,940	8,900
III	4,360	1,920	1,440	4,440	2,560	2,440	3,000	4,440	1,260	2,900	1,820
IV	5,060	5,280	5,840	4,980	4,300	7,380	5,400	8,200	10,080	7,720	6,340
III & IV	9,420	7,200	7,280	9,420	6,860	9,820	8,400	10,640	11,340	10,620	8,160

TABLE XII

SUBJECT NUMBER 3: CONSECUTIVE NIGHTS

	NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
				1	2	3	4	5	1	2	3	4
FIRST HALF	TOTAL TIME (seconds)	12,600	12,640	12,360	12,600	12,700	12,560	12,440	12,540	12,500	12,300	12,660
	STAGE AW	80	200	1,500	1,340	1,260	460	700	380	100	160	360
	I	2,480	2,540	1,040	1,380	900	1,340	3,320	3,060	2,040	3,480	2,040
	II	3,740	3,880	3,720	2,920	4,260	3,840	1,420	1,140	1,620	1,300	2,820
	III	2,040	1,560	700	2,400	1,980	1,060	2,000	1,920	780	1,500	1,640
	IV	4,340	4,480	5,400	4,560	4,300	5,860	5,000	6,040	7,960	5,860	5,800
	III & IV	6,320	6,040	6,100	6,960	6,280	6,860	7,140	7,960	8,740	7,300	7,440
SECOND HALF	TOTAL TIME (seconds)	12,640	12,620	12,400	12,560	12,760	12,640	12,440	12,520	12,580	12,320	12,660
	STAGE AW	480	1,280	580	420	1,260	180	800	0	940	300	660
	I	4,880	6,040	5,140	4,200	8,900	4,980	9,060	6,120	5,380	5,120	5,200
	II	4,240	4,140	5,500	5,480	2,020	4,580	1,180	1,720	3,660	3,640	6,080
	III	2,320	360	740	2,040	580	1,380	1,000	2,520	480	1,400	180
	IV	720	800	440	420	0	1,520	400	2,160	2,220	1,860	540
	III & IV	3,100	1,160	1,180	2,460	580	2,960	1,260	4,680	2,700	3,260	720

TABLE XIII

PERCENTAGE

SUBJECT NUMBER 3: CONSECUTIVE NIGHTS

	NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
				1	2	3	4	5	1	2	3	4
TOTAL	STAGE AW	2.2	5.8	8.4	6.9	9.8	2.5	6.0	1.5	4.1	1.8	4.0
	I	29.1	33.8	24.9	22.1	38.4	25.0	49.7	36.6	29.5	34.9	28.5
	II	31.6	31.7	37.2	33.3	24.6	33.4	10.4	11.4	21.0	20.0	35.1
	III	17.2	7.6	5.8	17.6	10.0	9.6	13.1	17.7	5.0	11.7	7.1
	IV	20.0	20.9	23.5	19.7	16.8	29.2	21.7	32.7	40.1	31.3	25.0
	III & IV	37.2	28.5	29.3	37.3	26.8	38.8	34.8	50.5	45.1	43.0	32.1
FIRST HALF	STAGE AW	0.6	1.5	12.1	10.6	9.9	3.6	5.6	3.0	0.8	1.3	2.8
	I	19.6	20.0	8.4	10.9	7.0	10.6	26.6	24.4	16.3	28.2	16.1
	II	29.6	30.6	30.0	23.1	33.5	30.5	11.4	9.0	12.9	10.5	22.2
	III	16.1	12.3	5.6	19.0	15.5	8.4	16.0	15.3	6.2	12.1	12.9
	IV	34.4	35.4	43.6	36.1	33.8	46.6	40.1	48.1	63.6	47.6	45.8
	III & IV	50.5	47.7	49.2	55.1	49.3	55.0	56.1	63.4	69.6	59.7	58.7
SECOND HALF	STAGE AW	3.7	10.1	4.6	3.3	9.9	1.4	6.4	0	7.4	2.4	5.2
	I	38.6	47.8	41.4	33.2	69.7	39.3	72.8	48.8	42.7	41.5	41.0
	II	33.5	32.8	44.3	43.4	15.8	36.2	9.4	13.7	29.0	29.5	48.0
	III	18.3	2.8	5.9	16.1	4.5	10.9	8.0	20.1	3.8	11.3	1.4
	IV	5.6	6.3	3.5	3.3	0	12.0	3.2	17.2	17.6	15.0	4.2
	III & IV	23.9	9.1	9.4	19.4	4.5	22.9	11.2	37.3	21.4	26.3	5.6

TABLE XIV

SUBJECT NUMBER 3: CONSECUTIVE NIGHTS

NIGHT	CONTROL		EXPERIMENTAL					POST-EXPERIMENTAL			
			1	2	3	4	5	1	2	3	4
NUMBER OF STAGE SHIFTS											
TOTAL NIGHT	31	26	29	35	25	25	32	28	27	35	31
FIRST HALF	15	17	19	19	15	13	15	17	12	13	20
SECOND HALF	16	9	10	16	10	12	17	11	15	22	11
BODY MOVEMENTS (pages)											
TOTAL NIGHT	32	36	25	31	35	36	31	35	20	42	41
FIRST HALF	15	11	7	14	15	10	7	18	12	20	21
SECOND HALF	17	25	18	17	20	26	24	17	8	22	20
LATENCY (time to first REM of 50 uv)											
PAGES	176	161	281	236	501	467	490	171	191	156	174
MINUTES	59	52	94	79	167	156	163	57	64	52	58
NUMBER OF SHIFTS	7	7	11	8	13	12	13	5	4	5	8

FIGURE 23

Figure 23 shows the per-cent of sleep time subject 3 spent in each stage for the total night.

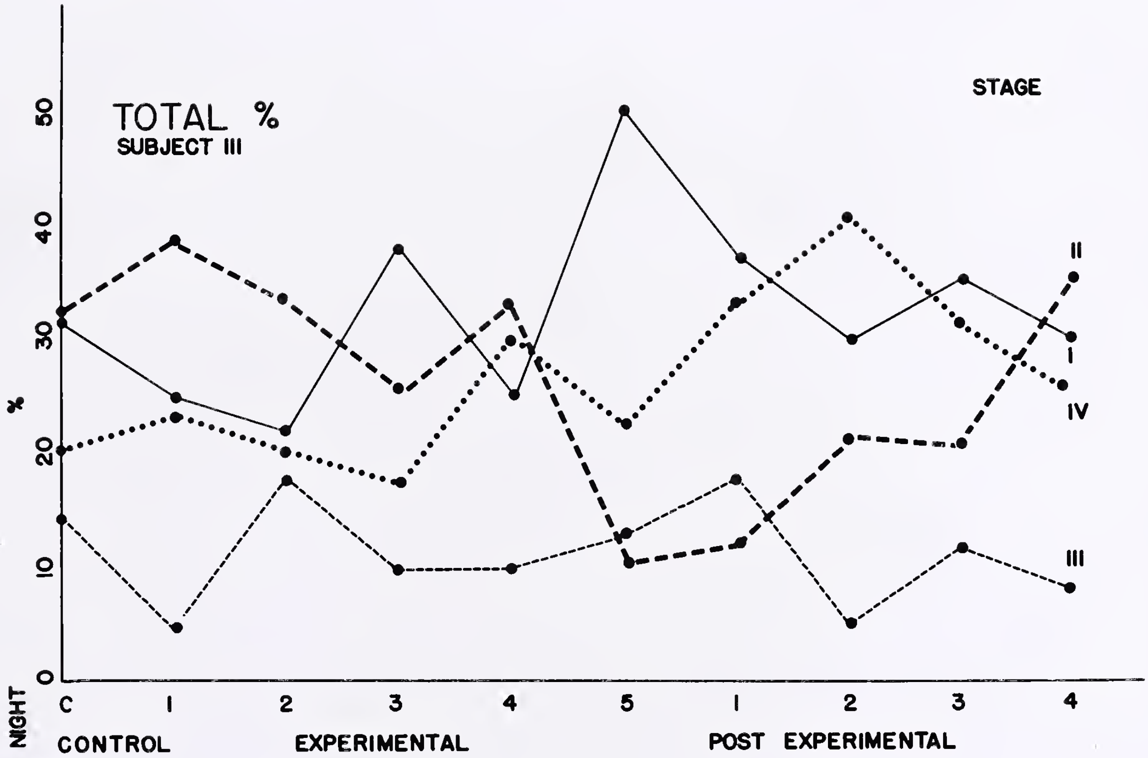
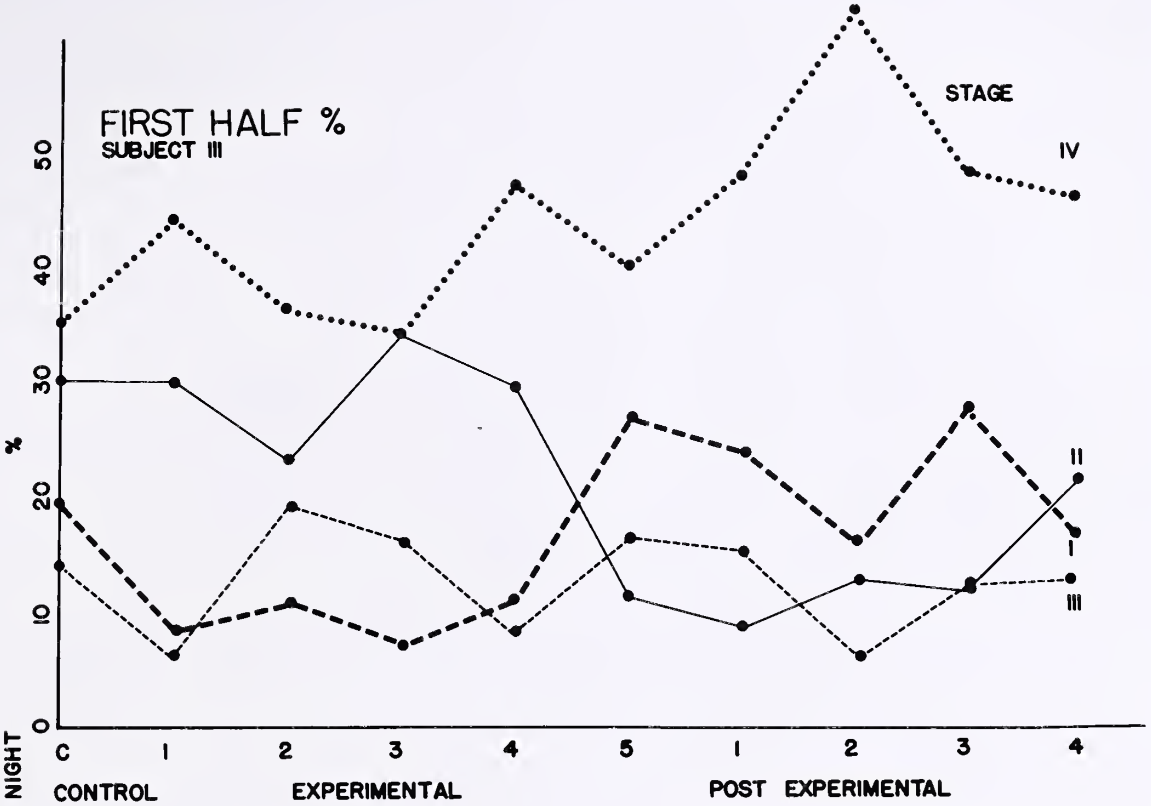

TOTAL %
SUBJECT III
STAGE
%
0
10
20
30
40
50
II
I
IV
III
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

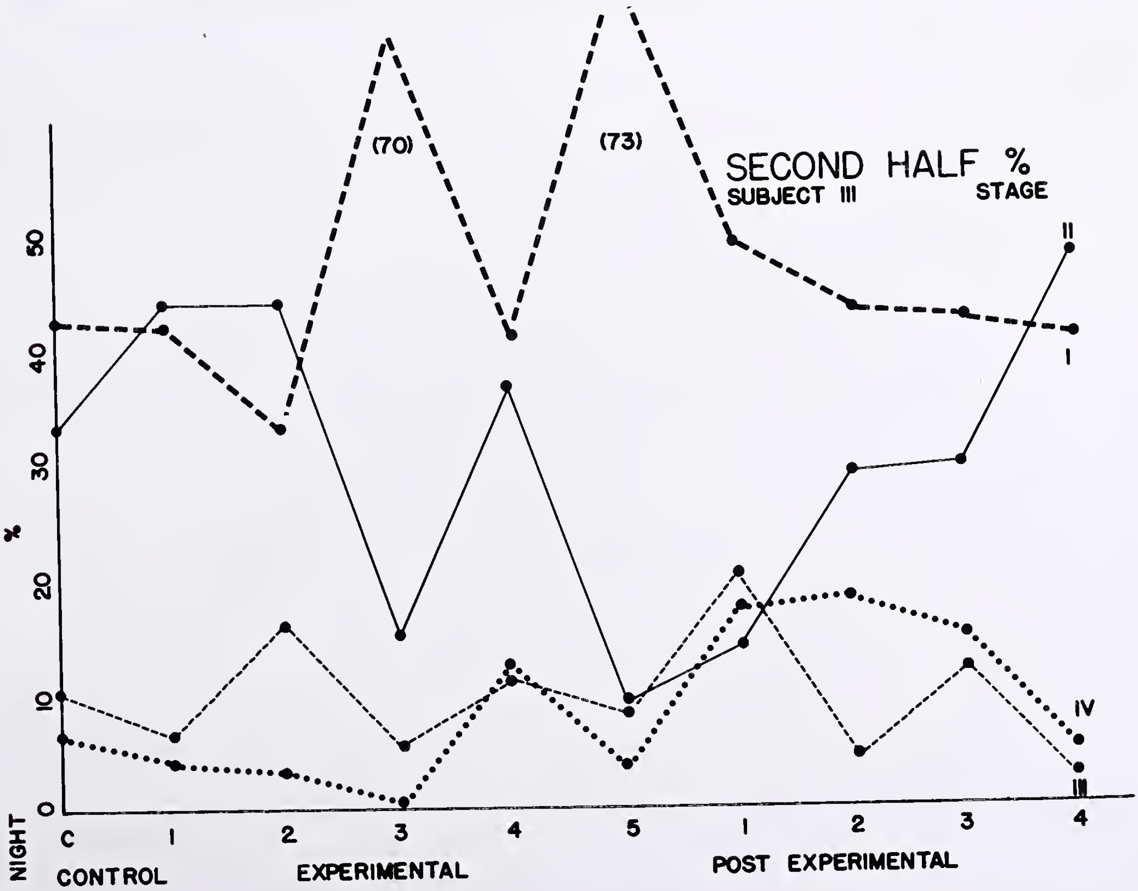
FIGURE 24

Figure 24 shows the per-cent of sleep time subject 3 spent in each stage for the first half night.

FIGURE 25

Figure 25 shows the per-cent of sleep time subject 3 spent in each stage for the second half night.


FIRST HALF %
SUBJECT III
STAGE
IV
II
I
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL


(70)
(73)
SECOND HALF %
SUBJECT III
STAGE
II
I
IV
III
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

II STAGES AND MODALITIES

Analysis of all subjects yields for each modality the following information:
Stage 1: Total night Stage 1 follows the same pattern in each subject, decreasing on the first X night and increasing thereafter to peak and then return to control levels during the recovery nights when alcohol is no longer being administered. If a Stage 1 increase on a given X night is great, the next night Stage 1 is lower. Table XV indicates that the percentage of time in Stage 1 is greater on X nights and even greater on post-alcohol nights.

Stage 1 constitutes a smaller portion of the first half night than it does the second half or total night. Here as in the total, the Stage 1 decreases the first X night, then increases above C values (the exception is the subject who responded more apparently in PE nights) on alcohol administered nights, only to return to C levels on post-alcohol nights. Subject two's X night Stage 1 average is two times his C level; but Subject one and three's Stage I is two thirds that of his C level (Table XVI).

This difference in subjects is maintained in the second half of the night where Subject 2 has a C level on X nights (Table XVI), but Subject 1 and 3 have a 10% increase on X and PX nights. All subjects, however, show a pattern which is reflected so vividly in the total night (Figure 28); but the pattern is more erratic and accounts for peaks seen in total night data.

AW: Observation of the composite data (Table XVII) on the amount of time spent in AW by each subject indicates that where AW was greater than 2% of the total sleep time (Subject 2 and 3) more AW was found on X nights. In subjects with stable Stage 1 changes (Subject 1 and 2) AW was greater in the second half X nights. In Subject 3, where 1 was unstable in the second half, AW was greater in the first half of X nights. Thus all subjects showed an increase of AW on X nights during either the first or second half of the night.

BM: As seen in Table XVIII, BMs are decreased on alcohol nights. This decrease takes place in the first half of the night and is followed on PX nights by an increase in BMs.

Number of Stage Shifts: Constancy of the number of stage shifts for any given subject is the outstanding feature of Table XIX. There is no consistent relationship between the number of stage shifts in the first and second half or in nights where Stage I or IV is unusually high. Each subject has the same number of shifts in C, X, and PX nights.

Latency: Review of the time from onset of sleep to the first REM period indicates the remarkable similarity between C and PX nights. Alcohol nights vary in the following manner:

	Experimental Nights		
Subject 1	1↓	2-3↑	4-5↓
Subject 2	1↑	2--	5↓
Subject 3	1	---	5↑

with peaks at very high Stage 1 nights.

When latency is shorter, the number of shifts until the first REM is less, and the number of shifts is greater when latency is longer.

Stage II: Stage II follows the same pattern in all the subjects- increasing in X-1, decreasing in X 2-5, leveling off on PX 1 only to rise to C levels on the post-alcohol nights. The total pattern is not reflected in the first half of the night which shows an erratic Stage II, but rather in the second half of the night. Stage II consistently slopes inversely to Stage I from night to night.

Stage III: Stage III is fairly constant from night to night, with Subject 3 having the most erratic pattern. The first half night shows the same pattern as the total night with the second half the most erratic but always varying about the C level.

Stage IV: Stage IV is constant in Subject 1 and 2, but in Subject 3 after X-3 is greater than C levels and decreases toward C levels on PX nights. This pattern is the same in the first half nights. Stage IV in the second half is fairly constant with higher percentages in the PC nights.

Stage III and IV: Stages III and IV combined for the total nights vary about control levels. Subject 3 has high values after X-3. There is no significant consistent pattern in the first half night, and although erratic in the second half values, remain around C levels.

FIGURE 26

Figure 26 shows the per-cent of time that each subject spent in Stage I for the total night.

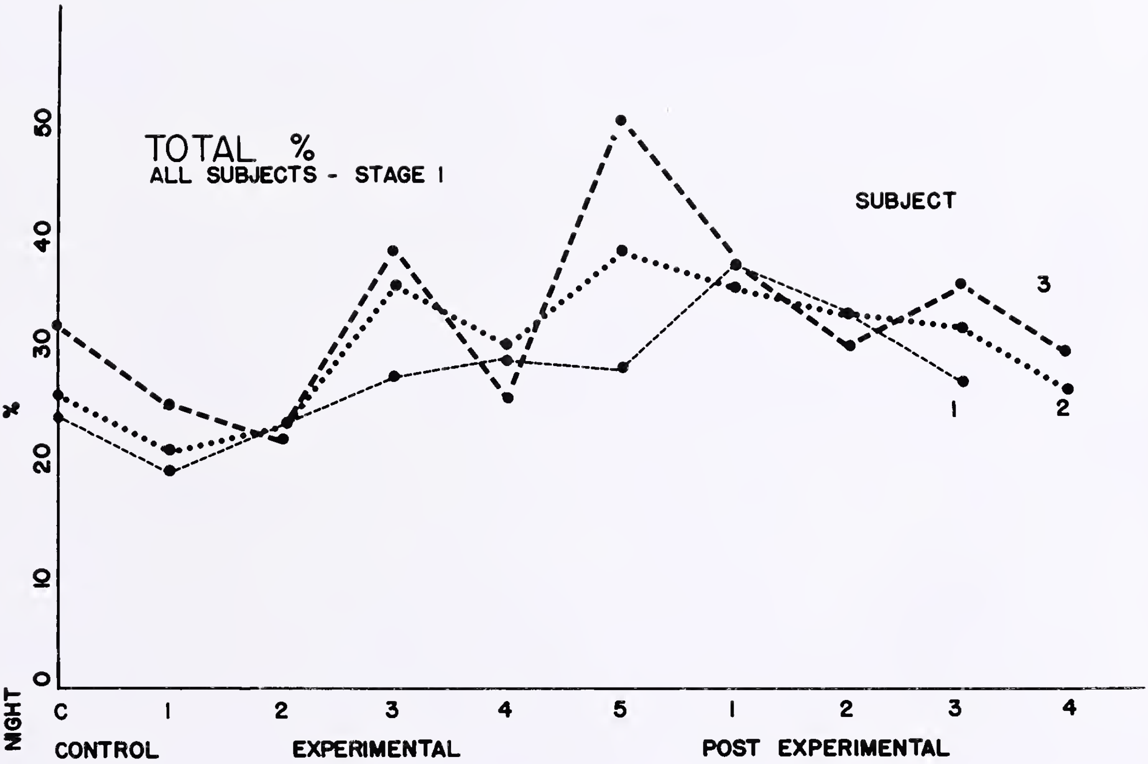
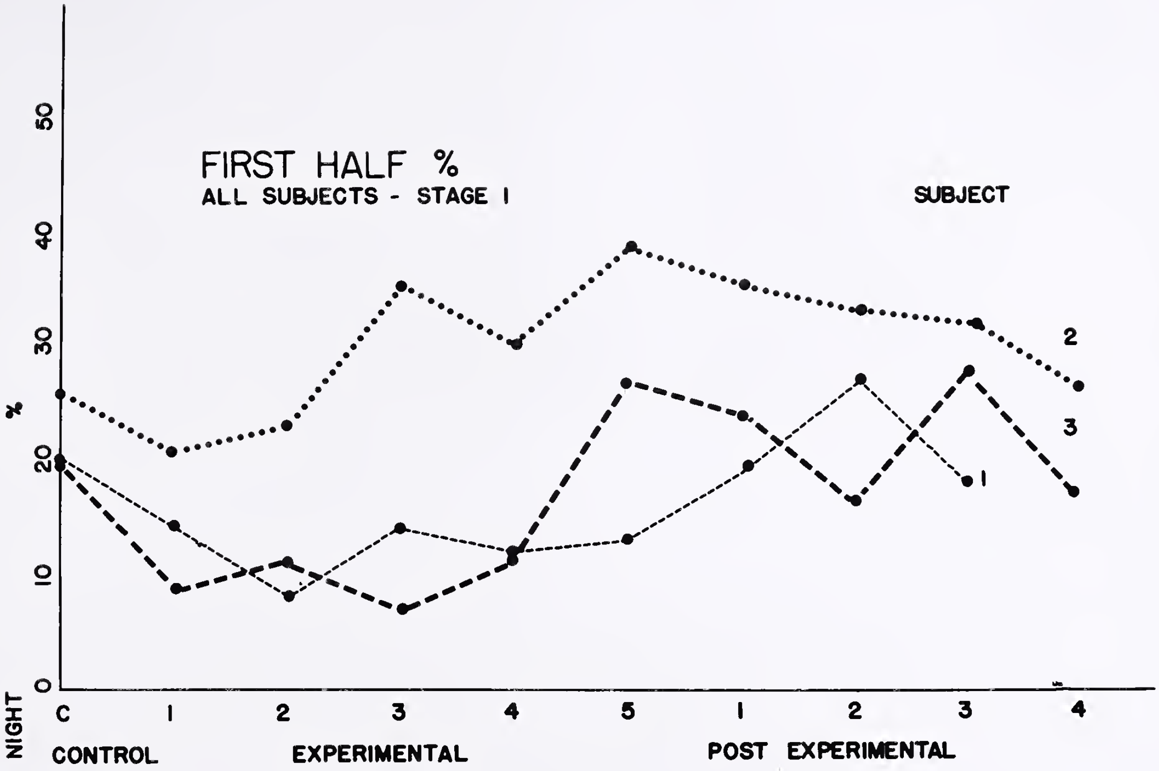

TOTAL %
ALL SUBJECTS - STAGE I
SUBJECT
1
2
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 27

Figure 27 shows the per-cent of time that each subject spent in Stage I for the first half night.

FIGURE 28

Figure 28 shows the per-cent of time that each subject spent in Stage I for the second half night.


FIRST HALF %
ALL SUBJECTS - STAGE I
SUBJECT
2
3
1
%
50
40
30
20
10
0
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

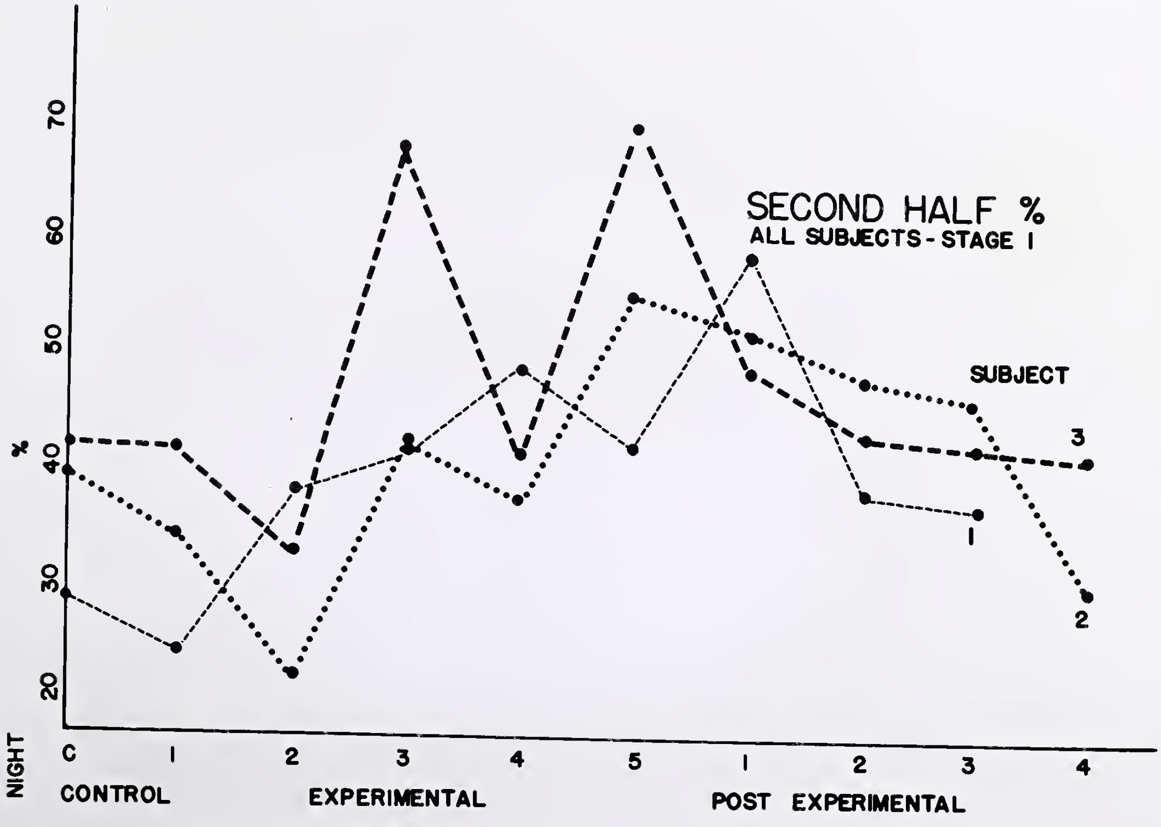

SECOND HALF %
ALL SUBJECTS - STAGE I
SUBJECT
3
1
2
%
70
60
50
40
30
20
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 29

Figure 29 shows the per-cent of time that each subject spent in Stage II for the total night.

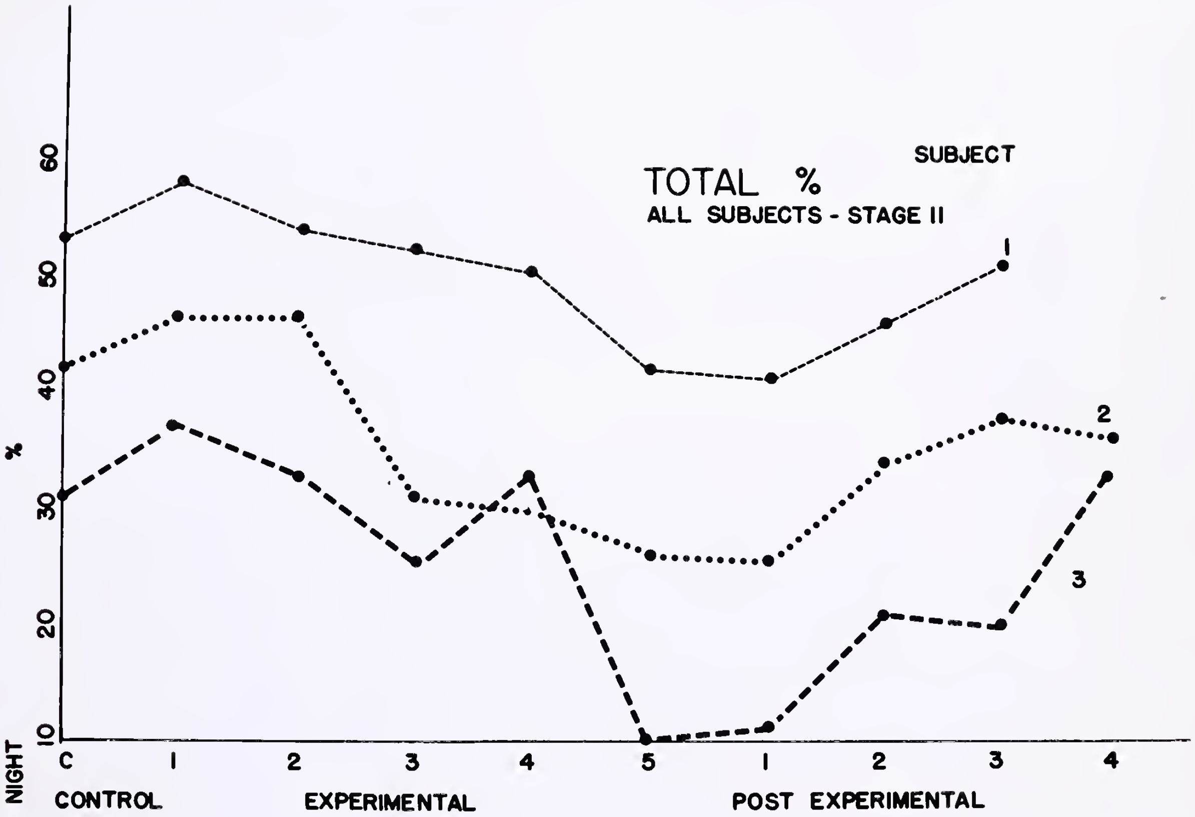
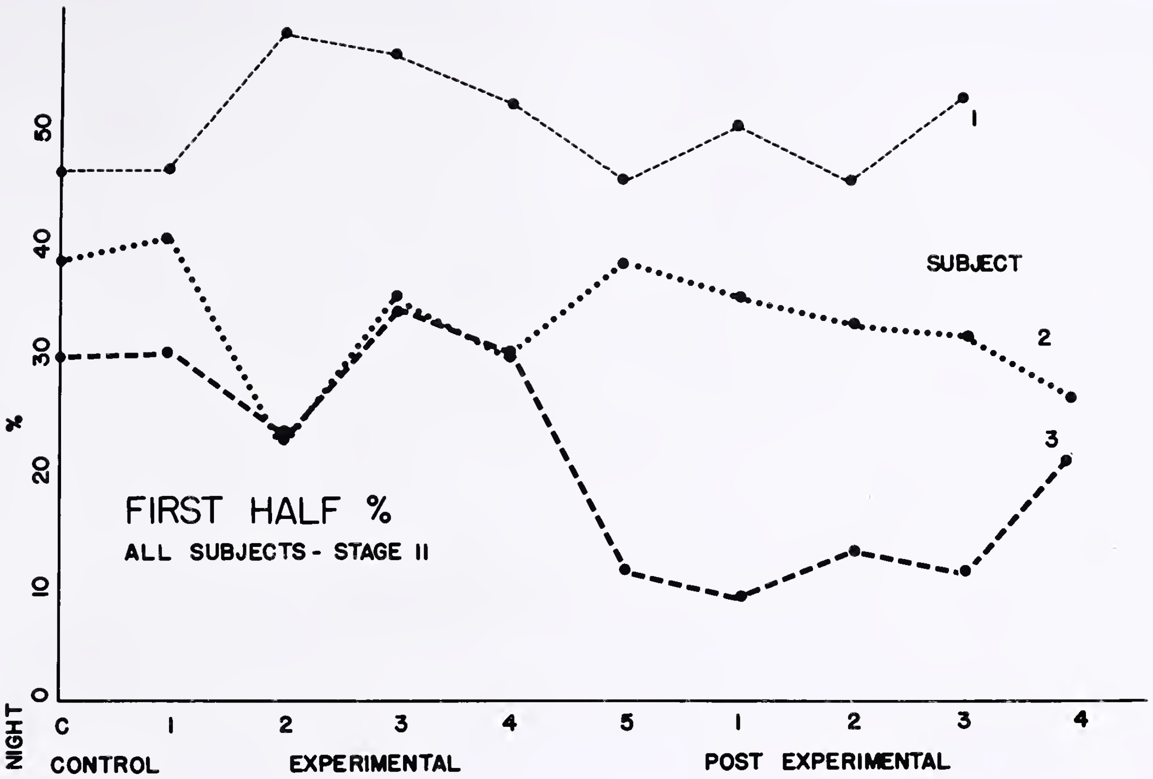

TOTAL %
ALL SUBJECTS - STAGE II
SUBJECT
1
2
3
%
60
50
40
30
20
10
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 30

Figure 30 shows the per-cent of time that each subject spent in Stage II for the first half night.

FIGURE 31

Figure 31 shows the per-cent of time that each subject spent in Stage II for the second half night.


FIRST HALF %
ALL SUBJECTS - STAGE II
SUBJECT
1
2
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

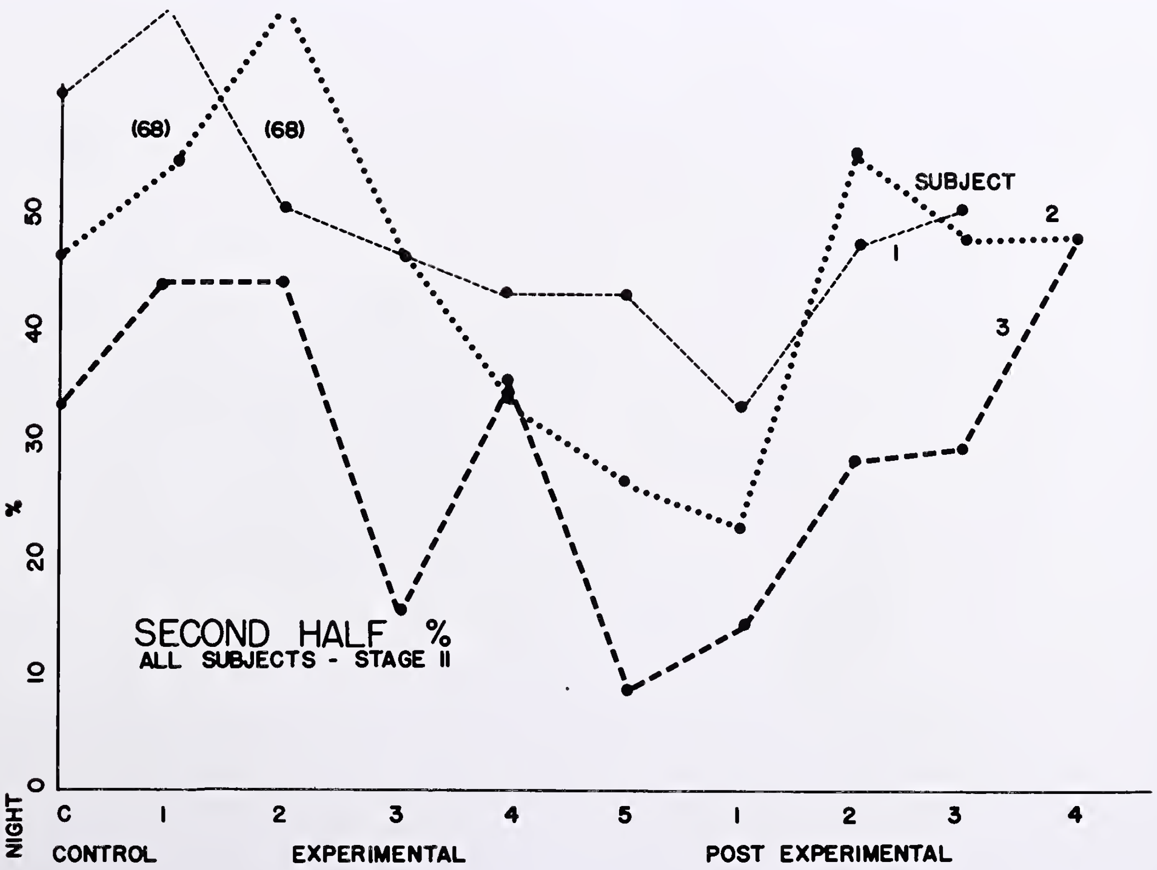

SECOND HALF %
ALL SUBJECTS - STAGE II
(68)
(68)
SUBJECT
1
2
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 32

Figure 32 shows the per-cent of time that each subject spent in Stage III for the total night.

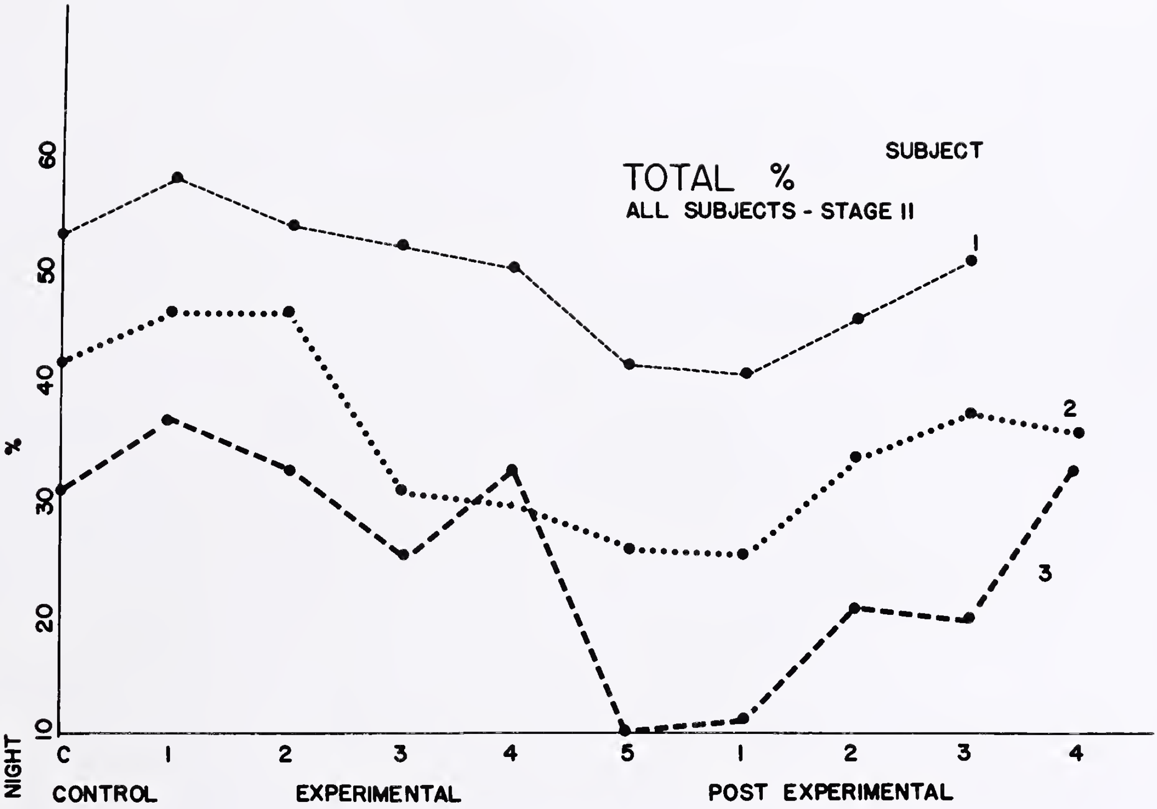
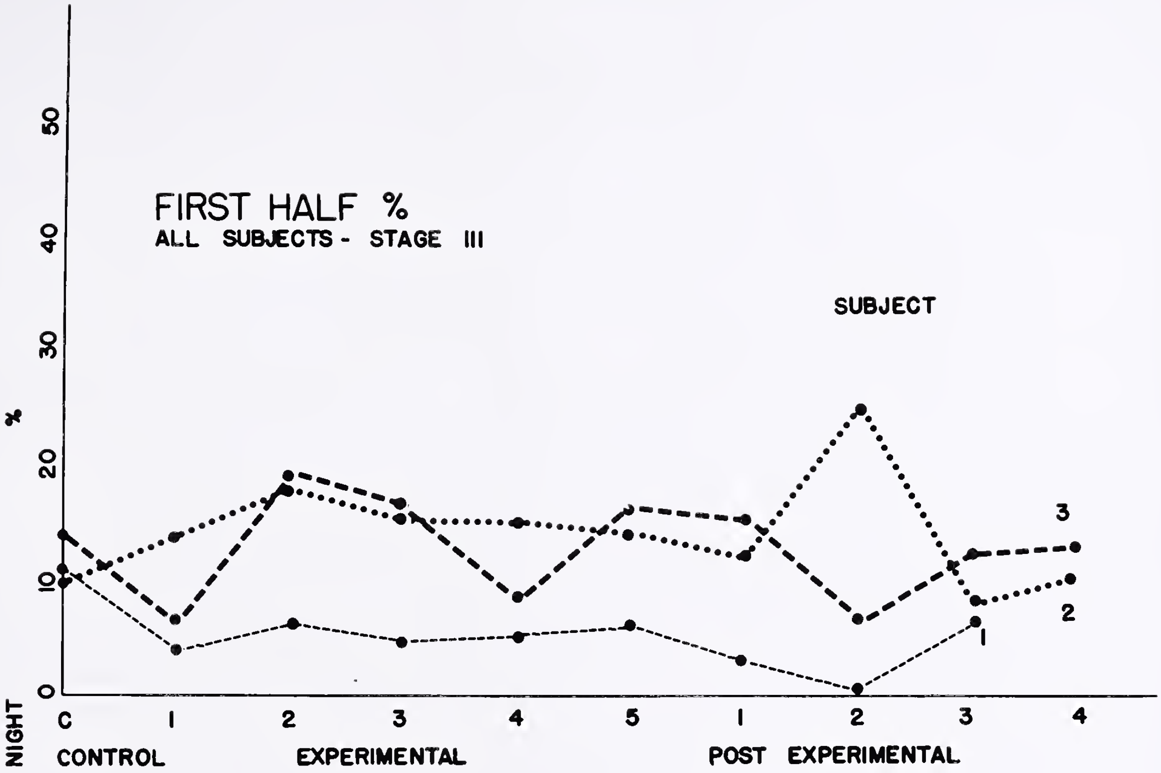

TOTAL %
ALL SUBJECTS - STAGE II
SUBJECT
1
2
3
%
60
50
40
30
20
10
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 33

Figure 33 shows the per-cent of time that each subject spent in Stage III for the first half night.

FIGURE 34

Figure 34 shows the per-cent of time that each subject spent in Stage III for the second half night.


FIRST HALF %
ALL SUBJECTS - STAGE III
SUBJECT
1
2
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

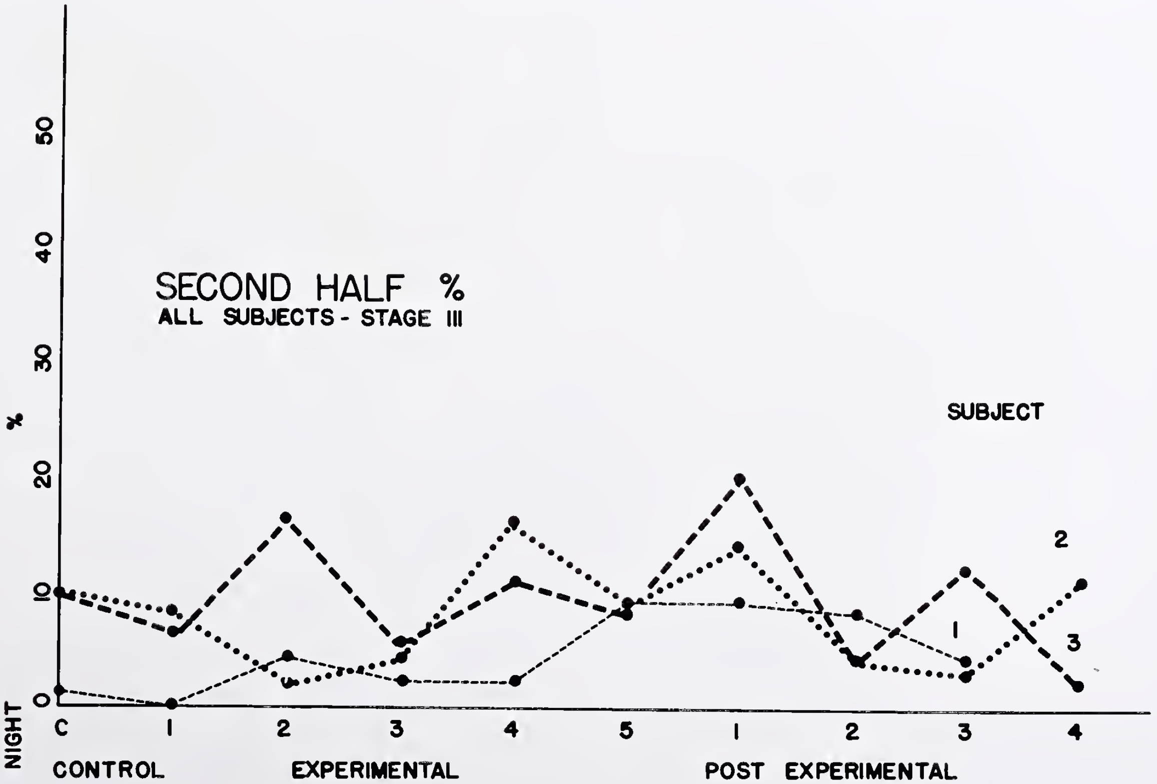

SECOND HALF %
ALL SUBJECTS - STAGE III
SUBJECT
1
2
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 35

Figure 35 shows the per-cent of time that each subject spent in Stage IV for the total night.

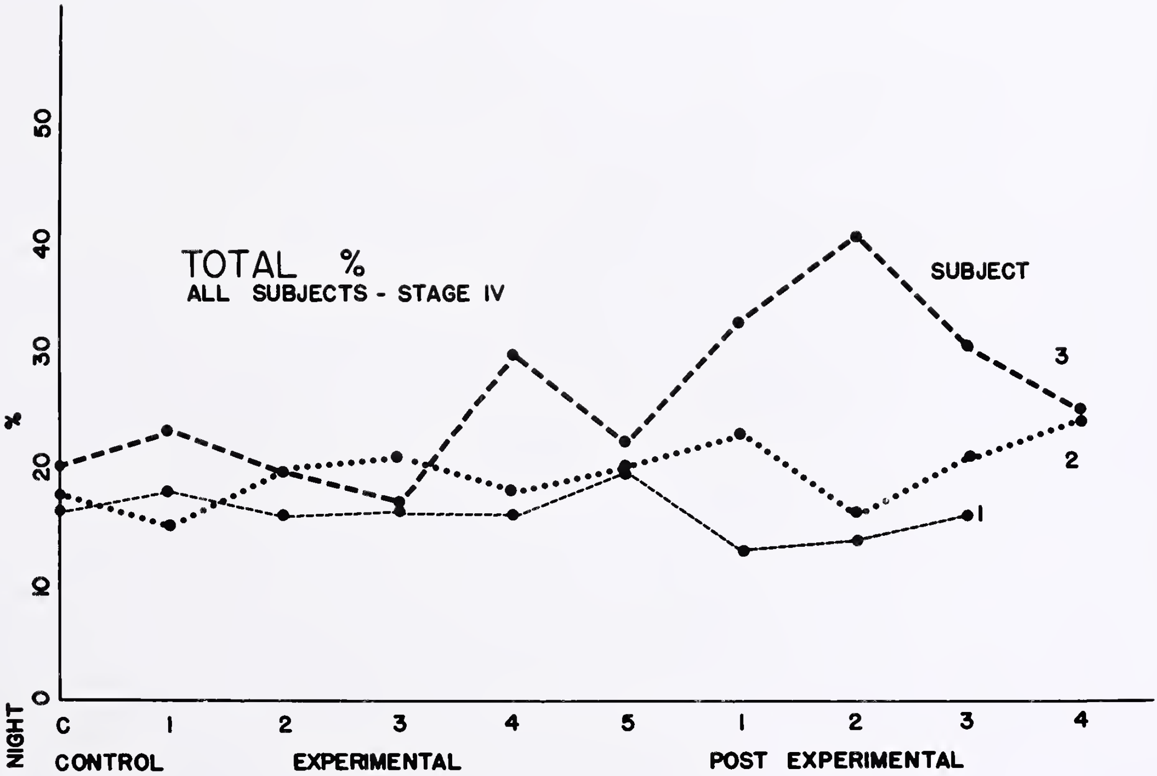
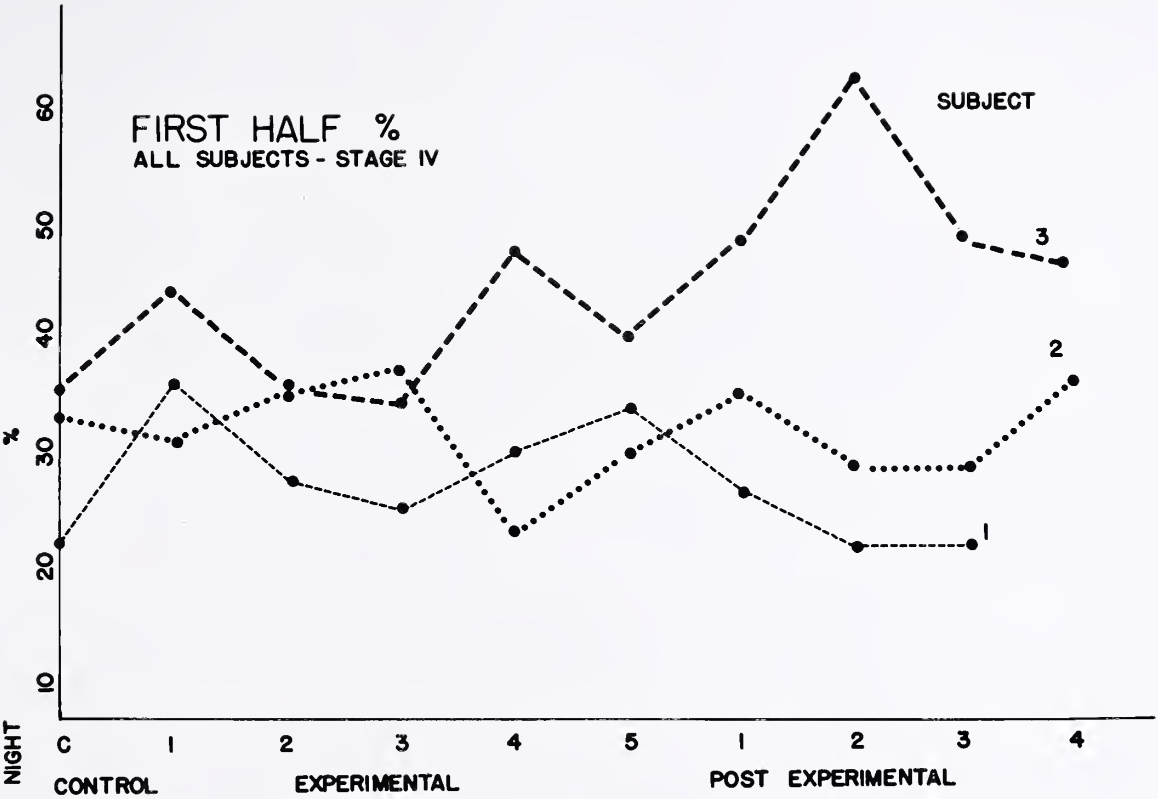

TOTAL %
ALL SUBJECTS - STAGE IV
SUBJECT
3
2
1
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 36

Figure 36 shows the per-cent of time that each subject spent in Stage IV for the first half night.

FIGURE 37

Figure 37 shows the per-cent of time that each subject spent in Stage IV for the second half night.


FIRST HALF %
ALL SUBJECTS - STAGE IV
SUBJECT
3
2
1
%
60
50
40
30
20
10
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

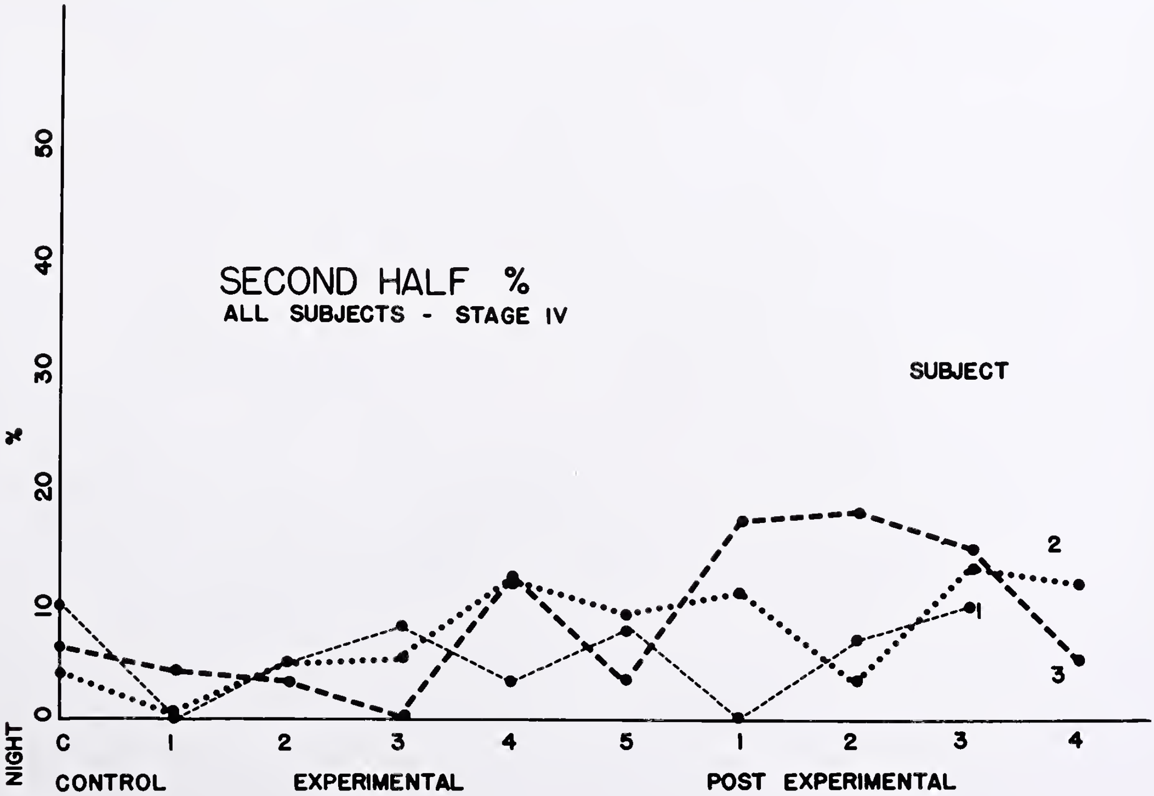

SECOND HALF %
ALL SUBJECTS - STAGE IV
SUBJECT
2
1
3
%
50
40
30
20
10
0
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 38

Figure 38 shows the per-cent of time that each subject spent in Stages III - IV for the total night.

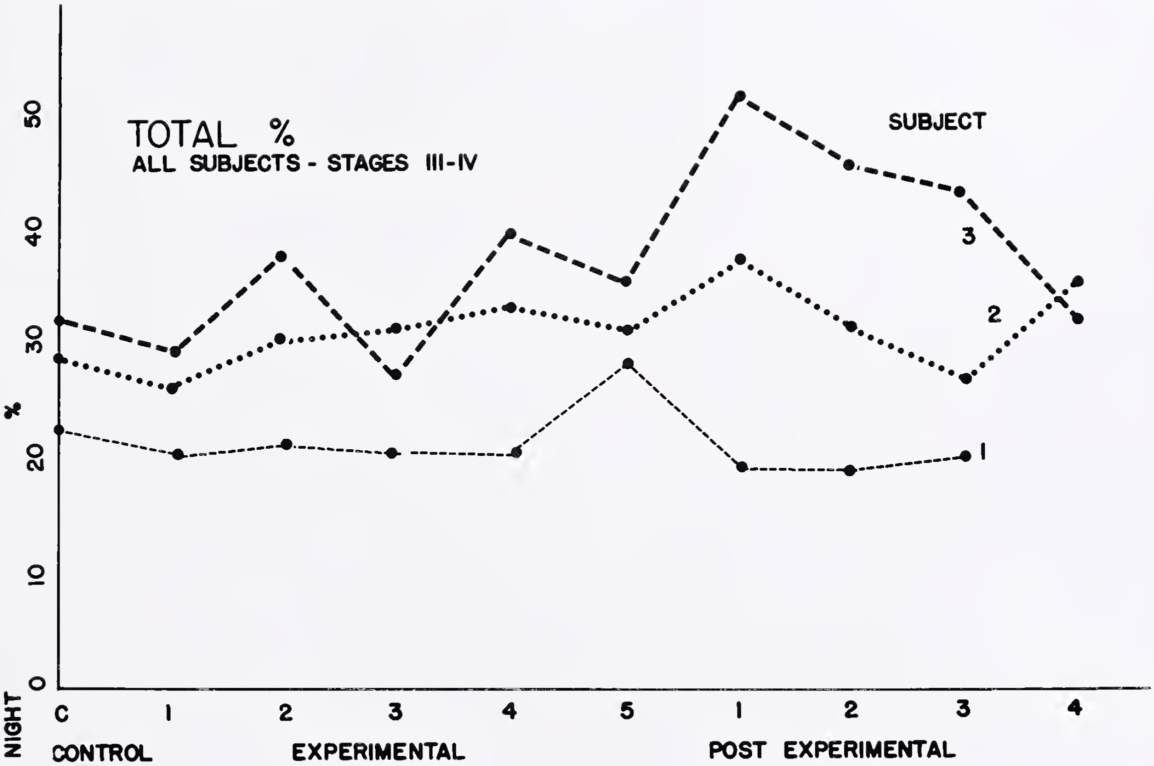
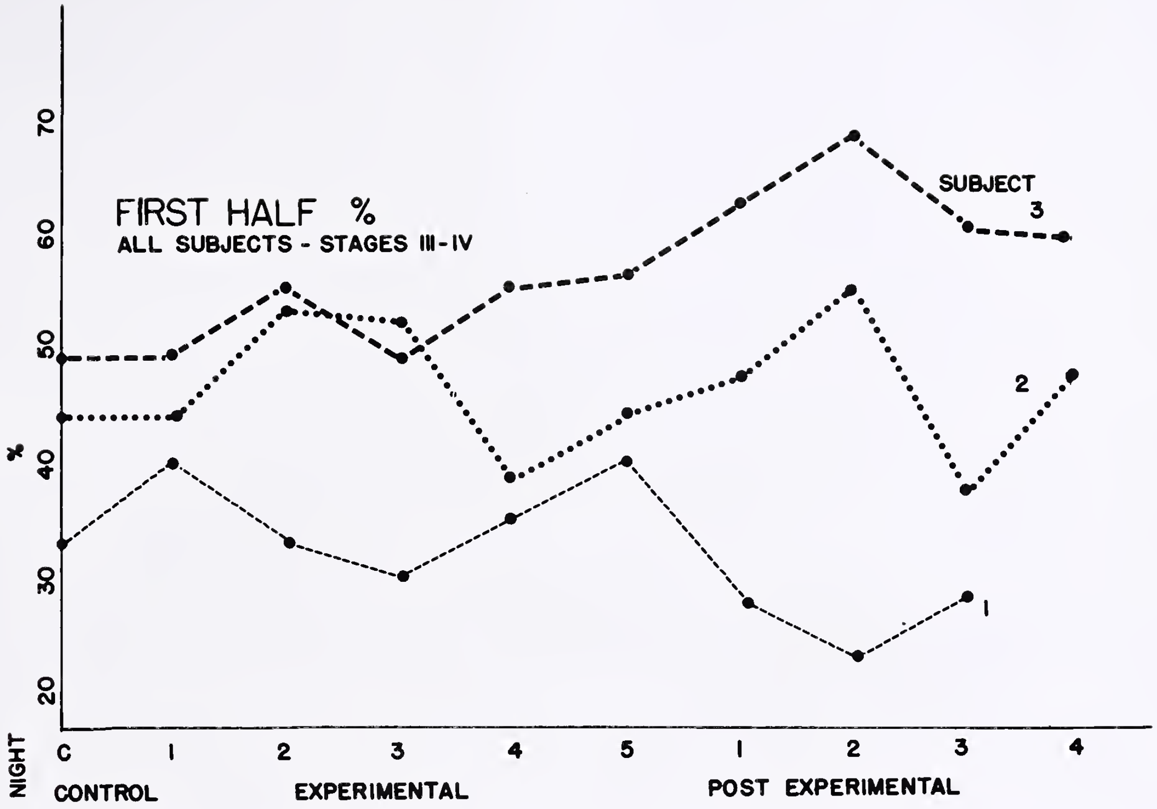

TOTAL %
ALL SUBJECTS - STAGES III-IV
SUBJECT
3
2
1
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

FIGURE 39

Figure 39 shows the per-cent of time that each subject spent in Stages III - IV for the first half night.

FIGURE 40

Figure 40 shows the per-cent of time that each subject spent in Stages III - IV for the second half night.


FIRST HALF %
ALL SUBJECTS - STAGES III-IV
SUBJECT
3
2
1
%
20
30
40
50
60
70
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

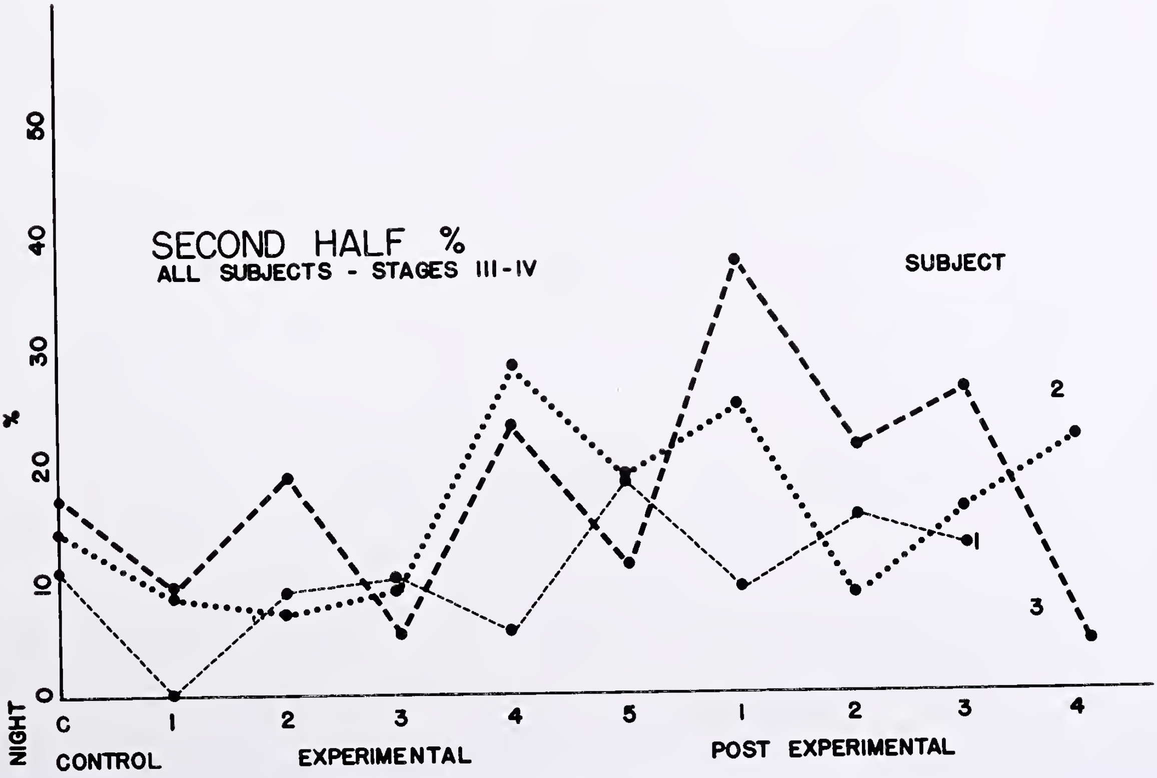

SECOND HALF %
ALL SUBJECTS - STAGES III-IV
SUBJECT
2
1
3
%
0
10
20
30
40
50
NIGHT
C
1
2
3
4
5
1
2
3
4
CONTROL
EXPERIMENTAL
POST EXPERIMENTAL

TABLE XV

MEAN OF ALL SUBJECTS
CONSECUTIVE NIGHTS
STAGE I (REM)

NIGHTS	CONTROL	EXPERIMENTAL					POST-EXPERIMENTAL			
		1	2	3	4	5	1	2	3	4
TOTAL	27.4	21.7	22.8	33.6	28.5	38.5	36.2	31.7	31.5	27.1
FIRST HALF	17.4	10.4	15.2	16.2	14.8	20.2	20.4	23.8	25.4	18.7
SECOND HALF	37.2	32.9	31.1	50.9	41.7	56.4	51.5	39.5	34.9	36.6

TABLE XV (CONTINUED)

MEAN PER-CENT

STAGE	NIGHT	CONTROL MEAN	ALCOHOL 1	ALCOHOL 2	ALCOHOL 3	ALCOHOL 4	ALCOHOL 5	POST ALCOHOL 1	POST ALCOHOL 2	POST ALCOHOL 3	POST ALCOHOL 4
AW	TOTAL	3	6	3	5	4	4	2	3	2	4
	FIRST HALF	4	6	4	6	6	6	3	3	3	5
	SECOND HALF	2	6	2	5	2	2	1	2	1	3
II	TOTAL	42	47	44	36	37	26	26	34	36	36
	FIRST HALF	39	39	34	34	37	27	29	23	31	24
	SECOND HALF	47	56	55	37	37	26	23	44	43	48
III	TOTAL	10	6	11	8	10	11	12	8	8	9
	FIRST	12	8	14	12	10	12	10	11	9	12
	SECOND HALF	7	5	8	4	10	9	14	5	6	6
IV	TOTAL	18	19	19	18	21	21	23	23	23	25
	FIRST HALF	30	37	33	32	33	35	37	38	33	42
	SECOND HALF	7	1	4	4	9	7	9	9	13	8

TABLE XVI

ALL SUBJECTS

AVERAGE OF CONSECUTIVE NIGHTS

PERCENT STAGE I (REM)

NIGHT	CONTROL	EXPERIMENTAL	POST-EXPERIMENTAL
TOTAL			
SUBJECT 1	24.0	25.5	32.4
SUBJECT 2	26.3	29.4	33.4
SUBJECT 3	31.4	32.2	33.6
FIRST HALF			
SUBJECT 1	19.5	12.1	21.4
SUBJECT 2	12.5	24.4	24.2
SUBJECT 3	20.0	12.7	18.7
SECOND HALF			
SUBJECT 1	28.5	38.7	43.8
SUBJECT 2	39.8	38.0	38.9
SUBJECT 3	43.2	51.3	43.4
TOTAL		(EXPERIMENTAL 2 - 5)	
SUBJECT 1	24.0	27.0	32.4
SUBJECT 2	26.0	31.5	33.4
SUBJECT 3	31.0	34.0	33.6

TABLE XVII

ALL SUBJECTS

AVERAGE OF CONSECUTIVE NIGHTS

PERCENT AWAKE

NIGHT	CONTROL	EXPERIMENTAL	POST-EXPERIMENTAL
TOTAL			
SUBJECT 1	0.3	1.6	1.8
SUBJECT 2	3.8	4.4	2.8
SUBJECT 3	4.0	6.8	2.9
FIRST HALF			
SUBJECT 1	0.6	0.5	2.8
SUBJECT 2	6.2	6.8	5.7
SUBJECT 3	1.1	8.3	1.9
SECOND HALF			
SUBJECT 1	0	2.7	0.6
SUBJECT 2	0	2.0	0
SUBJECT 3	6.9	5.1	4.0

TABLE XVIII

ALL SUBJECTS

AVERAGE OF CONSECUTIVE NIGHTS

PAGES OF BODY MOVEMENTS (BM)

NIGHT	CONTROL	EXPERIMENTAL	POST-EXPERIMENTAL
TOTAL			
SUBJECT 1	23.0	21.0	22.0
SUBJECT 2	30.5	29.0	42.5
SUBJECT 3	34.0	31.6	34.5
FIRST HALF			
SUBJECT 1	12.0	10.0	15.0
SUBJECT 2	16.0	14.0	24.5
SUBJECT 3	13.0	11.0	18.0
SECOND HALF			
SUBJECT 1	11.0	11.0	12.0
SUBJECT 2	14.5	15.0	20.5
SUBJECT 3	21.0	21.0	17.0

TABLE XIX

ALL SUBJECTS
AVERAGE OF CONSECUTIVE NIGHTS
NUMBER OF STAGE SHIFTS

NIGHT	CONTROL	EXPERIMENTAL	POST-EXPERIMENTAL
TOTAL			
SUBJECT 1	24	24	24
SUBJECT 2	27	29	28
SUBJECT 3	29	29	30
FIRST HALF			
SUBJECT 1	16	15	13
SUBJECT 2	16	18	18
SUBJECT 3	16	16	18
SECOND HALF			
SUBJECT 1	7	10	9
SUBJECT 2	11	15	11
SUBJECT 3	21	21	17

TABLE XX

LENGTH/REM PERIOD (NUMBER OF SECONDS x 10)

DIVISION OF NIGHTS FOR ANALYSIS	NIGHTS		CONTROL		ALCOHOL					POST-ALCOHOL			
			1	2	1	2	3	4	5	1	2	3	4
TOTAL	Subject	1	85	--	46	65	79	52	65	76	79	7	--
		2	50	82	53	59	74	41	69	63	104	82	65
		3	52	71	44	34	81	63	61	91	46	53	45
	MEAN		51	77	48	53	78	52	65	77	76	68	55
FIRST HALF	Subject	1	70	--	35	20	24	28	29	34	48	43	--
		2	16	48	30	51	44	28	34	37	60	61	45
		3	42	42	17	24	22	33	55	51	34	58	25
	MEAN		29	45	27	32	30	30	39	41	47	54	35
SECOND HALF	Subject	1	101	--	43	134	149	71	101	100	92	134	--
		2	94	75	52	47	131	58	115	82	118	76	95
		3	61	101	64	42	111	83	64	153	53	51	65
	MEAN		78	88	53	74	130	71	93	112	88	87	80

III. COMMON PROPERTIES

The following observations apply to all of the subjects:

1. a. Stage I REM decreases the first alcohol night, gradually increases and exceeds control levels, only on post-alcohol nights to return to control levels.

b. This shift in Stage I takes place in the first half of the night and even to a greater extent in the second half of the night.

c. Stage I occupies the largest percentage of the second half of the night.

2. Stage II varies inversely with Stage I, increasing proportionally to any Stage I decrease and decreasing proportionally to any Stage I increase.

3. Stage III and IV vary about control levels, following a more erratic course during the second half of the night.

b. Stage IV occupies the largest percentage of the first half of the night.

4. The per-cent of time spent in AWake on alcohol nights is not statistically significantly different than the per-cent on other nights.

5. The decrease in body movements on alcohol nights which takes place in the first half of the night and is followed on post-alcohol nights by an increase in body movements is not statistically significant.

6. The number of stage shifts for each subject is the same on all nights.

7. The latency to the first REM is identical on control and post-alcohol nights but varies on experimental nights.

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